OBSTRUCTIVE SLEEP APNEA TREATMENT

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INSTRUCTIONS FOR USE

This protocol provides assistance in interpreting UnitedHealthcare benefit plans. When deciding coverage, the enrollee specific document must be referenced. The terms of an enrollee's document (e.g., Certificate of Coverage (COC) or Evidence of Coverage (EOC)) may differ greatly. In the event of a conflict, the enrollee's specific benefit document supersedes this protocol. All reviewers must first identify enrollee eligibility, any federal or state regulatory requirements and the plan benefit coverage prior to use of this Protocol. Other Protocols, Policies and Coverage Determination Guidelines may apply. UnitedHealthcare reserves the right, in its sole discretion, to modify its Protocols, Policies and Guidelines as necessary. This protocol is provided for informational purposes. It does not constitute medical advice. This policy does not govern Medicare Group Retiree members.

UnitedHealthcare may also use tools developed by third parties, such as the MCG™ Care Guidelines, to assist us in administering health benefits. The MCG™ Care Guidelines are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

COMMERCIAL & MEDICAID COVERAGE RATIONALE

Nonsurgical Treatment

Removable oral appliances are medically necessary for treating obstructive sleep apnea (OSA) as documented by polysomnography. Refer to the HCO Medical Protocol PUL004 titled Attended Polysomnography for Evaluation of Sleep Disorders for further information.

For information regarding medical necessity review, when applicable, see: MCG™ Care Guidelines, 21st edition, 2017, Oral Appliances (Mandibular Advancement Devices), A-0341 (ACG).
MCG™ Care Guidelines: Oral Appliances (Mandibular Advancement Devices) A-0341 (ACG):
Clinical Indications for Procedure

- Oral appliance (mandibular advancement device) may be indicated for 1 or more of the following:
  - Mild obstructive sleep apnea and ALL of the following:
    - CPAP not able to be used as long-term treatment, as indicated by 1 or more of the following:
      - Patient is intolerant of CPAP.
      - Patient refuses CPAP.
    - Sufficient dentition to allow for retention of appliance
    - No active periodontal disease or dental decay
    - No active temporomandibular joint disorder
    - No restriction in mandibular opening or protrusion
  - Moderate or severe obstructive sleep apnea, as a component of treatment that includes additional modalities

Inconclusive or Non-Supportive Evidence

For children, evidence is insufficient, conflicting, or poor and demonstrates an incomplete assessment of net benefit vs harm; additional research is recommended. Systematic reviews found that there is insufficient evidence for use of oral appliances in the treatment of obstructive sleep apnea in children.

For snoring, evidence is insufficient, conflicting, or poor and demonstrates an incomplete assessment of net benefit vs harm; additional research is recommended. An evidence-based review of oral appliances for treatment of snoring identified only 2 randomized crossover studies (with a total of 55 patients) that met criteria for analysis. Pooling of data found that, as compared with placebo at 12-week follow-up, oral appliances reduced snoring loudness by 38% and improved partner sleep disturbance by 54%, although there was no difference in daytime sleepiness of partners. The authors concluded there is no available evidence regarding long-term effects of oral appliances for snoring. A specialty society consensus statement notes that there is a lack of evidence on outcomes, adherence, and adverse effects, as well as appropriate patient selection, for the use of oral appliances in the treatment of snoring; however, the authors stated that treatment of snoring with an oral appliance may be an option.

*** End of MCG

Removable oral appliances are not medically necessary for treating central sleep apnea. This type of sleep apnea is caused by impaired neurological function, and these devices are designed to manage physical obstructions.

Nasal dilator devices are not medically necessary for treating obstructive sleep apnea (OSA). There is insufficient clinical evidence supporting the safety and efficacy of nasal dilators for treating OSA. Results from available studies indicate that therapeutic response is variable among the participants. Further research from larger, well-designed studies is needed to evaluate the effectiveness of the device compared with established treatments for OSA, to determine its long-term effectiveness and to determine which patients would benefit from this therapy.
Surgical Treatment
The following surgical procedures are medically necessary for treating obstructive sleep apnea as documented by polysomnography. Refer to the HCO Medical Protocol PUL004 titled “Attended Polysomnography for Evaluation of Sleep Disorders” for further information. Also, see the Definitions section below for information on the definitions and severity of OSA.

For information regarding medical necessity review, when applicable, see: MCG™ Care Guidelines, 21st edition, 2017:

- **Uvulopalatopharyngoplasty (UPPP)**
  For information regarding medical necessity review, when applicable, see MCG™ Care Guidelines, 21st edition, 2017, Uvulopalatopharyngoplasty (UPPP), A-0245 (ACG).

**MCG™ Care Guidelines: Uvulopalatopharyngoplasty (UPPP), A-0245 (ACG)**

**Clinical Indications for Procedure**

- Uvulopalatopharyngoplasty (UPPP) may be indicated when ALL of the following are present:
  - Mild obstructive sleep apnea (ie, apnea-hypopnea index or respiratory disturbance index between 5 and 15, determined with polysomnography)
  - Obstructive sleep apnea symptoms, as indicated by ALL of the following:
    - Excessive daytime sleepiness documented using Epworth Sleepiness Scale or other validated scale
    - Excessive daytime sleepiness interferes with daily activity or work (eg, causes safety issues).
  - CPAP trial with well-supported follow-up and involvement by qualified sleep specialist has clearly failed due to 1 or more of the following:
    - Claustrophobia
    - Difficulty tolerating pressure
    - Failure to improve symptoms
    - Inability to sleep with CPAP device
    - Intolerance of nasal or mouth interface
    - Nasal irritation
    - Removal of CPAP device unintentionally during sleep
  - Isolated oropharyngeal narrowing demonstrated as source of airway obstruction
  - Use of oral appliance has resulted in 1 or more of the following:
    - Failure to improve symptoms
    - Intolerance to device
    - Physician considers use of dental device inappropriate given patient's anatomy.
  - Weight not a concern, or weight loss tried and failed in obese patient

**End of MCG**

- **Maxillomandibular advancement surgery (MMA)**
  For information regarding medical necessity review, when applicable, see MCG™ Care Guidelines, 21st edition, 2017, Maxillomandibular Osteotomy and Advancement, A-0248 (ACG). Also, see the HCO Medical Protocol titled Orthognatic (Jaw) Surgery
MCG™ Care Guidelines: Maxillomandibular Osteotomy and Advancement, A-0248 (ACG).

Clinical Indications for Procedure

Maxillomandibular osteotomy and advancement may be indicated for 1 or more of the following:

- Obstructive sleep apnea and ALL of the following
  - CPAP trial with well-supported follow-up and involvement by qualified sleep specialist has clearly failed due to 1 or more of the following:
    - Claustrophobia
    - Difficulty tolerating pressure
    - Failure to improve symptoms
    - Inability to sleep with CPAP device
    - Intolerance of nasal or mouth interface
    - Nasal irritation
    - Removal of CPAP device unintentionally during sleep
  - Craniofacial disproportion or deformities, with evidence of maxillomandibular deficiency
  - Moderate or severe obstructive sleep apnea (ie, apnea-hypopnea index or respiratory disturbance index 15 or greater, determined with polysomnography)
  - Symptoms of obstructive sleep apnea, as indicated by ALL of the following:
    - Excessive daytime sleepiness has been documented using Epworth Sleepiness Scale or other validated scale.
    - Excessive daytime sleepiness interferes with daily activity or work (eg, causes safety issues).
  - Use of oral appliance has resulted in 1 or more of the following:
    - Failure to improve symptoms
    - Intolerance to device
    - Physician considers use of dental device inappropriate given patient's anatomy.
  - Weight not concern, or weight loss tried and failed in obese patient
- Performed as part of cleft palate repair
- Performed as part of complex repair of craniofacial anomaly (eg, for Pierre Robin sequence, Treacher Collins syndrome, Nager syndrome)

**End of MCG

- Multilevel Procedures Whether Done In A Single Surgery Or Phased Multiple Surgeries.
  There are a variety of procedure combinations, including mandibular osteotomy and genioglossal advancement with hyoid myotomy (GAHM). For information regarding medical necessity review, when applicable, see MCG™ Care Guidelines, 21st edition, 2017 Mandibular Osteotomy, A-0247 (ACG).

MCG™ Care Guidelines: Mandibular Osteotomy, A-0247 (ACG)

Clinical Indications for Procedure

Mandibular osteotomy may be indicated for 1 or more of the following:

- Mandibular retrognathism (class II malocclusion) or mandibular prognathism (class III malocclusion) that has not corrected after trial of nonsurgical treatment with 1 or more of the following:
  - Functional appliance
  - Headgear
• Orthodontics
  • Obstructive sleep apnea and ALL of the following:
    • CPAP trial with well-supported follow-up and involvement by qualified sleep specialist has clearly failed due to 1 or more of the following:
      ▪ Claustrophobia
      ▪ Difficulty tolerating pressure
      ▪ Failure to improve symptoms
      ▪ Inability to sleep with CPAP device
      ▪ Intolerance of nasal or mouth interface
      ▪ Nasal irritation
      ▪ Removal of CPAP device unintentionally during sleep
    • Functional obstruction mostly retrolingual or lower pharyngeal
    • Moderate or severe obstructive sleep apnea (ie, apnea-hypopnea index or respiratory disturbance index 15 or greater, determined with polysomnography)
    • Symptoms of obstructive sleep apnea, as indicated by ALL of the following:
      ▪ Excessive daytime sleepiness has been documented using Epworth Sleepiness Scale or other validated scale.
      ▪ Excessive daytime sleepiness interferes with daily activity or work (eg, causes safety issues).
    • Use of oral appliance has resulted in 1 or more of the following:
      ▪ Failure to improve symptoms
      ▪ Intolerance to device
      ▪ Physician considers use of dental device inappropriate given patient's anatomy.
    • Weight not of concern, or weight loss tried and failed in obese patient
      ▪ Performed as part of cleft palate repair
      ▪ Performed as part of complex repair of craniofacial anomaly (eg, for Pierre Robin sequence, Treacher Collins syndrome, Nager syndrome)

**End of MCG

The following surgical procedures are **not medically necessary** for treating obstructive sleep apnea:
• Laser-assisted uvulopalatoplasty (LAUP)
• Palatal implants
• Lingual suspension - also referred to as tongue stabilization, tongue stitch or tongue fixation
• Transoral robotic surgery (TORS)
• Implantable hypoglossal nerve stimulation
• Radiofrequency ablation of the soft palate and/or tongue base

There is insufficient evidence to conclude that laser-assisted uvulopalatoplasty (LAUP) results in improved apnea-hypopnea index (AHI) or secondary outcomes. Some studies saw a worsening of symptoms as well as increased complications.

Results of studies provide preliminary but inconsistent evidence that palatal implants benefit patients with mild to moderate OSA. However, the magnitude of the benefits has been small; the largest randomized controlled trial (RCT) found that average OSA worsened in spite of treatment; and the
available studies involved \( \leq 1 \) year of patient monitoring after treatment. Additional studies are needed to determine the role of palatal implants in the management of OSA.

There is insufficient evidence to support the safety, efficacy and long-term outcomes of lingual suspension in the treatment of OSA. The published peer-reviewed medical literature includes a few small, uncontrolled studies with short-term follow-up. Large, controlled studies, with long-term follow-up, comparing lingual suspension to established procedures are necessary.

There is insufficient evidence to support the safety, efficacy and long-term outcomes of transoral robotic surgery (TORS) in the treatment of OSA. Large, controlled studies, with long-term follow-up, comparing TORS to established procedures are necessary.

There is insufficient evidence to support the safety, efficacy and long-term outcomes of hypoglossal nerve stimulation in the treatment of OSA. The optimal patient selection criteria for the use of hypoglossal nerve stimulation have not been defined. Randomized controlled trials or comparative effectiveness trials with long-term follow-up, comparing hypoglossal nerve stimulation to establish procedures are necessary to evaluate the effectiveness of this technology.

There is insufficient evidence to support the efficacy and long-term outcomes of radiofrequency ablation of the tongue or soft palate in the treatment of OSA. Optimal patient selection criteria have not been defined. Large controlled studies or comparative effectiveness trials with long-term follow-up comparing radiofrequency ablation to established procedures are necessary.

Follow-up polysomnography should be performed following surgery to evaluate response to treatment (Kushida et al., 2006; Ferguson et al., 2006). Refer to the Medical Protocol titled “Attended Polysomnography for Evaluation of Sleep Disorders” for further information.

**Medicaid Policy on Respiratory Devices (Accessed April 2017)**

**Bi-Level Positive Airway Pressure (BiPAP) Device Qualifications**

For an E0470 or E0471 Respiratory Assist Device (RAD) to be covered, the treating physician must fully document in the recipient’s medical record symptoms characteristic of sleep-associated hypoventilation, such as daytime hypersomnolence, excessive fatigue, morning headache, cognitive dysfunction, dyspnea, etc. A RAD (E0470, E0471) used to administer Noninvasive Positive Pressure Respiratory Assistance (NPPRA) therapy is covered for those recipients with clinical disorder groups characterized as (Group I) restrictive thoracic disorders (e.g., progressive neuromuscular diseases or severe thoracic cage abnormalities), (Group II) severe chronic obstructive pulmonary disease (COPD), (Group III) central sleep apnea (CSA), or (Group IV) obstructive sleep apnea (OSA) (E0470 only) and who also meet the following criteria:

**Group IV: Obstructive Sleep Apnea (OSA):**

Criteria (a) and (b) are both met:

a. A complete facility-based, attended polysomnogram has established the diagnosis of obstructive sleep apnea according to the following criteria:

1. The apnea-hypopnea index (AHI) is \( \geq 15 \) events per hour; or
2. The AHI is from 5 to 14 events per hour with documented symptoms of:
a. Excessive daytime sleepiness, impaired cognition, mood disorders or insomnia; or 
b. Hypertension, ischemic heart disease, or history of stroke; 
and
b. A single level device E0601, Continuous Positive Airway Pressure (CPAP) device has been tried and proven ineffective.

Continuous Positive Airway Pressure Device (CPAP) (E0601) Qualifications
1. A single level continuous positive airway pressure (CPAP) device (E0601) is covered if the recipient has a diagnosis of obstructive sleep apnea (OSA) documented by an attended, facility-based polysomnogram and meets either of the following criteria (a or b):
   a. The AHI is > 15 events per hour; or
   b. The AHI is from 5 to 14 events per hour with documented symptoms of:
      1. Excessive daytime sleepiness, impaired cognition, mood disorders, or insomnia; or
      2. Hypertension, ischemic heart disease, or history of stroke.

Note: The AHI must be calculated based on a minimum of 2 hours of recorded sleep and must be calculated using actual recorded hours of sleep (e.g., the AHI may not be an extrapolated or a projected calculation).

2. Continued coverage of an E0601 device beyond the first three months of therapy requires that, no sooner than the 61st day but no later than 120 days after initiating therapy, the supplier ascertain from either the recipient or the treating physician that the recipient is continuing to use the CPAP device. Continued use is defined as an average of four hours per 24 hour period.

DEFINITIONS
According to the American Academy of Sleep Medicine (AASM) the diagnosis of OSA is confirmed if the number of obstructive events (apneas, hypopneas + respiratory event related arousals) on polysomnography (PSG) is greater than 15 events/hour or greater than 5/hour in a patient who reports any of the following: unintentional sleep episodes during wakefulness; daytime sleepiness; unrefreshing sleep; fatigue; insomnia; waking up breath holding, gasping or choking; or the bed partner describing loud snoring, breathing interruptions or both during the patient’s sleep (Epstein et al., 2009).

†The frequency of obstructive events is reported as an apnea-hypopnea index (AHI) or respiratory disturbance index (RDI). RDI has at times been used synonymously with AHI, but at other times has included the total of apneas, hypopneas and respiratory effort related arousals (RERAs) per hour of sleep. When a portable monitor is used that does not measure sleep, the RDI refers to the number of apneas plus hypopneas per hour of recording.

OSA severity is defined as
• mild for AHI or RDI ≥ 5 and < 15
• moderate for AHI or RDI ≥ 15 and ≤ 30
• severe for AHI or RDI > 30/hr
MEDICARE COVERAGE RATIONALE

Medicare does not have a National Coverage Determination (NCD) for oral appliances used for the treatment of obstructive sleep apnea (OSA).

Medicare has a National Coverage Determination for Continuous Airway Pressure (CPAP) Therapy for Obstructive Sleep Apnea (OSA) (240.4). Medicare has Local Coverage Determinations (LCDs) for Nevada for Oral Appliances for Obstructive Sleep Apnea (L33611) and Positive Airway Pressure (PAP) Devices for the Treatment of Obstructive Sleep Apnea (L33718). (Accessed April 2017)

Medicare does not have a National Coverage Determination (NCD) for surgical treatment of obstructive sleep apnea (OSA). Local Coverage Determinations (LCDs) for Nevada do not exist at this time. (Accessed April 2017)

Medicare does not have a National Coverage Determination (NCD) for implantable hypoglossal nerve stimulation (Inspire® Upper Airway Stimulation (UAS)) used in the treatment of obstructive sleep apnea (OSA). Local Coverage Determinations (LCDs) do not exist at this time. (Accessed March 2017)

Continuous Positive Airway Pressure (CPAP) Therapy for Obstructive Sleep Apnea (OSA) (240.4)

General

Continuous Positive Airway Pressure (CPAP) is a non-invasive technique for providing single levels of air pressure from a flow generator, via a nose mask, through the nares. The purpose is to prevent the collapse of the oropharyngeal walls and the obstruction of airflow during sleep, which occurs in obstructive sleep apnea (OSA).

The apnea hypopnea index (AHI) is equal to the average number of episodes of apnea and hypopnea per hour. The respiratory disturbance index (RDI) is equal to the average number of respiratory disturbances per hour.

Apnea is defined as a cessation of airflow for at least 10 seconds. Hypopnea is defined as an abnormal respiratory event lasting at least 10 seconds with at least a 30% reduction in thoracoabdominal movement or airflow as compared to baseline, and with at least a 4% oxygen desaturation.

The AHI and/or RDI may be measured by polysomnography (PSG) in a facility-based sleep study laboratory, or by a Type II home sleep test (HST) monitor, a Type III HST monitor, or a Type IV HST monitor measuring at least 3 channels.

Indications and Limitations of Coverage

Nationally Covered Indications

Effective for claims with dates of service on and after March 13, 2008, the Centers for Medicare & Medicaid Services (CMS) determines that CPAP therapy when used in adult patients with OSA is considered reasonable and necessary under the following situations:
1. The use of CPAP is **covered** under Medicare when used in adult patients with OSA. Coverage of CPAP is initially limited to a 12-week period to identify beneficiaries diagnosed with OSA as subsequently described who benefit from CPAP. CPAP is subsequently **covered** only for those beneficiaries diagnosed with OSA who benefit from CPAP during this 12-week period.

2. The provider of CPAP must conduct education of the beneficiary prior to the use of the CPAP device to ensure that the beneficiary has been educated in the proper use of the device. A caregiver, for example a family member, may be compensatory, if consistently available in the beneficiary's home and willing and able to safely operate the CPAP device.

3. A positive diagnosis of OSA for the coverage of CPAP must include a clinical evaluation and a positive:
   a. attended PSG performed in a sleep laboratory; or
   b. unattended HST with a Type II home sleep monitoring device; or
   c. unattended HST with a Type III home sleep monitoring device; or
   d. unattended HST with a Type IV home sleep monitoring device that measures at least 3 channels.

4. The sleep test must have been previously ordered by the beneficiary’s treating physician and furnished under appropriate physician supervision.

5. An initial 12-week period of CPAP is **covered** in adult patients with OSA if either of the following criterion using the AHI or RDI are met:
   a. AHI or RDI greater than or equal to 15 events per hour, or
   b. AHI or RDI greater than or equal to 5 events and less than or equal to 14 events per hour with documented symptoms of excessive daytime sleepiness, impaired cognition, mood disorders or insomnia, or documented hypertension, ischemic heart disease, or history of stroke.

6. The AHI or RDI is calculated on the average number of events of per hour. If the AHI or RDI is calculated based on less than 2 hours of continuous recorded sleep, the total number of recorded events to calculate the AHI or RDI during sleep testing must be at a minimum the number of events that would have been required in a 2-hour period.

7. Apnea is defined as a cessation of airflow for at least 10 seconds. Hypopnea is defined as an abnormal respiratory event lasting at least 10 seconds with at least a 30% reduction in thoracoabdominal movement or airflow as compared to baseline, and with at least a 4% oxygen desaturation.

8. Coverage with Evidence Development (CED): Medicare provides the following limited coverage for CPAP in adult beneficiaries who do not qualify for CPAP coverage based on criteria 1-7 above. A clinical study seeking Medicare payment for CPAP provided to a beneficiary who is an enrolled subject in that study must address one or more of the following questions:
   a. In Medicare-aged subjects with clinically identified risk factors for OSA, how does the diagnostic accuracy of a clinical trial of CPAP compare with PSG and Type II, III & IV HST in identifying subjects with OSA who will respond to CPAP?
   b. In Medicare-aged subjects with clinically identified risk factors for OSA who have not undergone confirmatory testing with PSG or Type II, III & IV HST, does CPAP cause clinically meaningful harm?
The study must meet the following additional standards:

c. The principal purpose of the research study is to test whether a particular intervention potentially improves the participants’ health outcomes.

d. The research study is well-supported by available scientific and medical information or it is intended to clarify or establish the health outcomes of interventions already in common clinical use.

e. The research study does not unjustifiably duplicate existing studies.

f. The research study design is appropriate to answer the research question being asked in the study.

g. The research study is sponsored by an organization or individual capable of executing the proposed study successfully.

h. The research study is in compliance with all applicable Federal regulations concerning the protection of human subjects found at 45 CFR Part 46. If a study is Food and Drug Administration-regulated, it also must be in compliance with 21 CFR Parts 50 and 56.

i. All aspects of the research study are conducted according to the appropriate standards of scientific integrity.

j. The research study has a written protocol that clearly addresses, or incorporates by reference, the Medicare standards.

k. The clinical research study is not designed to exclusively test toxicity or disease pathophysiology in healthy individuals. Trials of all medical technologies measuring therapeutic outcomes as one of the objectives meet this standard only if the disease or condition being studied is life-threatening as defined in 21 CFR § 312.81(a) and the patient has no other viable treatment options.

l. The clinical research study is registered on the ClinicalTrials.gov Web site by the principal sponsor/investigator prior to the enrollment of the first study subject.

m. The research study protocol specifies the method and timing of public release of all pre-specified outcomes to be measured, including release of outcomes if outcomes are negative or study is terminated early. The results must be made public within 24 months of the end of data collection. If a report is planned for publication in a peer-reviewed journal, then that initial release may be an abstract that meets the requirements of the International Committee of Medical Journal Editors. However, a full report of the outcomes must be made public no later than 3 years after the end of data collection.

n. The research study protocol must explicitly discuss subpopulations affected by the treatment under investigation, particularly traditionally underrepresented groups in clinical studies, how the inclusion and exclusion criteria affect enrollment of these populations, and a plan for the retention and reporting of said populations in the trial. If the inclusion and exclusion criteria are expected to have a negative effect on the recruitment or retention of underrepresented populations, the protocol must discuss why these criteria are necessary.

o. The research study protocol explicitly discusses how the results are or are not expected to be generalizable to the Medicare population to infer whether Medicare patients may benefit from the intervention. Separate discussions in the protocol may be necessary for populations eligible for Medicare due to age, disability, or Medicaid eligibility.
Nationally Non-covered Indications
Effective for claims with dates of services on and after March 13, 2008, other diagnostic tests for the diagnosis of OSA, other than those noted above for prescribing CPAP, are not sufficient for the coverage of CPAP.

Oral Appliances for Obstructive Sleep Apnea (L33611)
Coverage Indications, Limitations, and/or Medical Necessity
A custom fabricated mandibular advancement oral appliance (E0486) used to treat obstructive sleep apnea (OSA) is covered if criteria A - D are met.
A. The beneficiary has a face-to-face clinical evaluation by the treating physician prior to the sleep test to assess the beneficiary for obstructive sleep apnea testing.
B. The beneficiary has a Medicare-covered sleep test that meets one of the following criteria (1 - 3):
   1. The apnea-hypopnea index (AHI) or Respiratory Disturbance Index (RDI) is greater than or equal to 15 events per hour with a minimum of 30 events; or,
   2. The AHI or RDI is greater than or equal to 5 and less than or equal to 14 events per hour with a minimum of 10 events and documentation of:
      a. Excessive daytime sleepiness, impaired cognition, mood disorders, or insomnia; or,
      b. Hypertension, ischemic heart disease, or history of stroke; or,
   3. If the AHI > 30 or the RDI > 30 and meets either of the following (a or b):
      a. The beneficiary is not able to tolerate a positive airway pressure (PAP) device; or,
      b. The treating physician determines that the use of a PAP device is contraindicated.
C. The device is ordered by the treating physician following review of the report of the sleep test.
   (The physician who provides the order for the oral appliance could be different from the one who performed the clinical evaluation in criterion A.)
D. The device is provided and billed for by a licensed dentist (DDS or DMD).

If all of these criteria (A-D) are not met, the custom fabricated oral appliance (E0486) will be denied as not reasonable and necessary.

Refer to the NONMEDICAL NECESSITY COVERAGE AND PAYMENT RULES section of the Policy Article for information about coverage for appliances that achieve their effect through positioning of the tongue (A9270).

A prefabricated oral appliance (E0485) will be denied as not reasonable and necessary. There is insufficient evidence to show that these items are effective therapy for OSA.

Custom fabricated mandibular advancement devices that have not received a written coding verification from the Pricing, Data Analysis, and Coding (PDAC) contractor will be denied as not reasonable and necessary.

Definitions
As used in this policy, physician refers to a licensed MD, DO, nurse practitioner, clinical nurse specialist, or physician's assistant working within their scope of practice. The term physician does not include a dentist (DDS or DMD).

Apnea is defined as the cessation of airflow for at least 10 seconds.
Hypopnea is defined as an abnormal respiratory event lasting at least 10 seconds associated with at least a 30% reduction in thoracoabdominal movement or airflow as compared to baseline, and with at least a 4% decrease in oxygen saturation.

The apnea-hypopnea index (AHI) is defined as the average number of episodes of apnea and hypopnea per hour of sleep without the use of a positive airway pressure device. For purposes of this policy, respiratory effort related arousals (RERAs) are not included in the calculation of the AHI. Sleep time can only be measured in a Type I (facility-based polysomnogram) or Type II sleep study (see descriptions below).

The respiratory disturbance index (RDI) is defined as the average number of apneas plus hypopneas per hour of recording without the use of a positive airway pressure device. For purposes of this policy, respiratory effort related arousals (RERAs) are not included in the calculation of the RDI. The RDI is reported in Type III, Type IV, and Other home sleep studies.

If the AHI or RDI is calculated based on less than 2 hours of sleep or recording time, the total number of recorded events used to calculate the AHI or RDI (respectively) must be at least the number of events that would have been required in a 2-hour period (i.e., must reach > 30 events without symptoms or > 10 events with symptoms). Projections of AHI or RDI based upon shorter testing times and/or fewer events are not acceptable for use in determining eligibility for payment.

Sleep Tests
Coverage and Payment rules for sleep tests may be found in the local coverage determinations (LCDs) for the applicable Medicare Part A or Part B contractor. There may be differences between those LCDs and the DME MAC LCD. For the purposes of coverage of oral appliances used to treat OSA, the DME MAC coverage, coding and payment rules take precedence.

Coverage of an oral appliance for the treatment of OSA is limited to claims where the diagnosis of OSA is based upon a Medicare-covered sleep test (Type I, II, III, IV, Other). A Medicare-covered sleep test must be either a polysomnogram performed in a facility-based laboratory (Type I study) or a home sleep test (HST) (Types II, III, IV, Other). The test must be ordered by the beneficiary's treating physician and conducted by an entity that qualifies as a Medicare provider of sleep tests and is in compliance with all applicable state regulatory requirements.

A Type I sleep test is the continuous and simultaneous monitoring and recording of various physiological and pathophysiological parameters of sleep with physician review, interpretation, and report. It is facility-based and must include sleep staging, which is defined to include a 1-4 lead electroencephalogram (EEG), and electro-oculogram (EOG), submental electromyogram (EMG) and electrocardiogram (ECG). It must also include at least the following additional parameters of sleep: airflow, respiratory effort, and oxygen saturation by oximetry. It may be performed as either a whole night study for diagnosis only or as a split night study to diagnose and initially evaluate treatment.

A HST is performed unattended in the beneficiary’s home using a portable monitoring device. A portable monitoring device for conducting an HST must meet one of the following criteria:
1. Type II device – Monitors and records a minimum of seven (7) channels: EEG, EOG, EMG, ECG/heart rate, airflow, respiratory movement/effort and oxygen saturation; or,
2. Type III device – Monitors and records a minimum of four (4) channels: respiratory movement/effort, airflow, ECG/heart rate and oxygen saturation; or,

3. Type IV device - Monitors and records a minimum of three (3) channels, one of which is airflow; or,

4. Other - Devices that monitor and record a minimum of three (3) channels that include actigraphy, oximetry and peripheral arterial tone and for which there is substantive clinical evidence in the published peer-reviewed medical literature that demonstrates that the results accurately and reliably correspond to an AHI or RDI as defined above. This determination will be made on a device-by-device basis (WatchPAT (Itamar Medical) is currently the only approved device in this category).

All beneficiaries who undergo a HST must, prior to having the test, receive instruction on how to properly apply a portable sleep monitoring device. This instruction must be provided by the entity conducting the HST and may not be performed by a DME supplier. Beneficiary instruction may be accomplished by either:

1. Face-to-face demonstration of the portable sleep monitoring device’s application and use; or,

2. Video or telephonic instruction, with 24-hour availability of qualified personnel to answer questions or troubleshoot issues with the device.

All sleep tests must be interpreted by a physician who holds either:

1. Current certification in Sleep Medicine by the American Board of Sleep Medicine (ABSM); or,

2. Current subspecialty certification in Sleep Medicine by a member board of the American Board of Medical Specialties (ABMS); or,

3. Completed residency or fellowship training in a program approved by an ABMS member board and has completed all the requirements for subspecialty certification in sleep medicine except the examination itself and only until the time of reporting of the first examination for which the physician is eligible; or,

4. Active staff membership of a sleep center or laboratory accredited by the American Academy of Sleep Medicine (AASM), Accreditation Commission for Health Care (ACHC) or The Joint Commission (formerly the Joint Commission on Accreditation of Healthcare Organizations – JCAHO).

No aspect of an HST, including but not limited to delivery and/or pickup of the device, may be performed by a DME supplier. This prohibition does not extend to the results of studies conducted by hospitals certified to do such test

Positive Airway Pressure (PAP) Devices for the Treatment of Obstructive SLEEP APNEA (L33718)

Definitions:

Apnea is defined as the cessation of airflow for at least 10 seconds.

Hypopnea is defined as an abnormal respiratory event lasting at least 10 seconds associated with at least a 30% reduction in thoracoabdominal movement or airflow as compared to baseline, and with at least a 4% decrease in oxygen saturation.

The apnea-hypopnea index (AHI) is defined as the average number of episodes of apnea and hypopnea per hour of sleep without the use of a positive airway pressure device. For purposes of this policy, respiratory effort related arousals (RERAs) are not included in the calculation of the AHI. Sleep time
can only be measured in a Type I (facility based polysomnogram) or Type II sleep study (see descriptions below).

The respiratory disturbance index (RDI) is defined as the average number of apneas plus hypopneas per hour of recording without the use of a positive airway pressure device. For purposes of this policy, respiratory effort related arousals (RERAs) are not included in the calculation of the RDI. The RDI is reported in Type III, Type IV, and Other home sleep studies.

If the AHI or RDI is calculated based on less than 2 hours of sleep or recording time, the total number of recorded events used to calculate the AHI or RDI (respectively) must be at least the number of events that would have been required in a 2 hour period (i.e., must reach \( \geq 30 \) events without symptoms or \( \geq 10 \) events with symptoms).

**Initial Coverage:**
In this policy, the term PAP (positive airway pressure) device will refer to both a single-level continuous positive airway pressure device (E0601) and a bi-level respiratory assist device without back-up rate (E0470) when it is used in the treatment of obstructive sleep apnea.

**I. An E0601 device is covered** for the treatment of obstructive sleep apnea (OSA) if criteria A – C are met:

A. The beneficiary has a face-to-face clinical evaluation by the treating physician prior to the sleep test to assess the beneficiary for obstructive sleep apnea.

B. The beneficiary has a sleep test (as defined below) that meets either of the following criteria (1 or 2):
   1. The apnea-hypopnea index (AHI) or Respiratory Disturbance Index (RDI) is greater than or equal to 15 events per hour with a minimum of 30 events; or,
   2. The AHI or RDI is greater than or equal to 5 and less than or equal to 14 events per hour with a minimum of 10 events and documentation of:
      a. Excessive daytime sleepiness, impaired cognition, mood disorders, or insomnia; or,
      b. Hypertension, ischemic heart disease, or history of stroke.

C. The beneficiary and/or their caregiver have received instruction from the supplier of the device in the proper use and care of the equipment.

If a claim for an E0601 is submitted and all of the criteria above have not been met, it will be denied as **not reasonable and necessary**.

**II. An E0470 device is covered** for those beneficiaries with OSA who meet criteria A-C above, in addition to criterion D:

D. An E0601 has been tried and proven ineffective based on a therapeutic trial conducted in either a facility or in a home setting.

Ineffective is defined as documented failure to meet therapeutic goals using an E0601 during the titration portion of a facility-based study or during home use despite optimal therapy (i.e., proper mask selection and fitting and appropriate pressure settings).

If E0470 is billed for a beneficiary with OSA and criteria A-D are not met, it will be denied as **not reasonable and necessary**.
A bi-level positive airway pressure device with back-up rate (E0471) is not reasonable and necessary if the primary diagnosis is OSA. If an E0471 is billed with a diagnosis of OSA, it will be denied as **not reasonable and necessary**.

If an E0601 device is tried and found ineffective during the initial facility-based titration or home trial, substitution of an E0470 does not require a new initial face-to-face clinical evaluation or a new sleep test.

If an E0601 device has been used for more than 3 months and the beneficiary is switched to an E0470, a new initial face-to-face clinical evaluation is required, but a new sleep test is not required. A new 3 month trial would begin for use of the E0470.

Coverage, coding and documentation requirements for the use of E0470 and E0471 for diagnoses other than OSA are addressed in the Respiratory Assist Devices (RAD) Local Coverage Determination (LCD) and related Policy Article (PA).

**Sleep Tests**

Coverage and Payment rules for sleep tests may be found in the LCDs for the applicable Medicare Part A or Part B contractor. There may be differences between those LCDs and the DME MAC LCD. For the purposes of coverage of PAP therapy, the DME MAC coverage, coding and payment rules take precedence.

Coverage of a PAP device for the treatment of OSA is limited to claims where the diagnosis of OSA is based upon a sleep test (Type I, II, III, IV, Other) that meets the Medicare coverage criteria in effect for the date of service of the claim for the PAP device. The sleep test must be either a polysomnogram performed in a facility-based laboratory (Type I study) or a home sleep test (HST) (Types II, III, IV, Other). The test must be ordered by the beneficiary’s treating physician and conducted by an entity that qualifies as a Medicare provider of sleep tests and is in compliance with all applicable state regulatory requirements.

A Type I sleep test is the continuous and simultaneous monitoring and recording of various physiological and pathophysiological parameters of sleep with physician review, interpretation, and report. It is facility-based and must include sleep staging, which is defined to include a 1-4 lead electroencephalogram (EEG), electro-oculogram (EOG), submental electromyogram (EMG) and electrocardiogram (ECG). It must also include at least the following additional parameters of sleep: airflow, respiratory effort, and oxygen saturation by oximetry. It may be performed as either a whole night study for diagnosis only or as a split night study to diagnose and initially evaluate treatment.

An HST is performed unattended in the beneficiary’s home using a portable monitoring device. A portable monitoring device for conducting an HST must meet one of the following criteria:

A. Type II device – Monitors and records a minimum of seven (7) channels: EEG, EOG, EMG, ECG/heart rate, airflow, respiratory movement/effort and oxygen saturation; or,

B. Type III device – Monitors and records a minimum of four (4) channels: respiratory movement/effort, airflow, ECG/heart rate and oxygen saturation; or,

C. Type IV device – Monitors and records a minimum of three (3) channels, one of which is airflow; or,

Other - Devices that monitor and record a minimum of three (3) channels that include actigraphy, oximetry and peripheral arterial tone and for which there is substantive clinical evidence in the
published peer-reviewed medical literature that demonstrates that the results accurately and reliably correspond to an AHI or RDI as defined above. This determination will be made on a device by device basis.

For all PAP devices, beneficiaries who undergo an HST must, prior to having the test, receive instruction on how to properly apply a portable sleep monitoring device. This instruction must be provided by the entity conducting the HST and may not be performed by a DME supplier. Beneficiary instruction may be accomplished by either:

1. Face-to-face demonstration of the portable sleep monitoring device’s application and use; or,
2. Video or telephonic instruction, with 24 hour availability of qualified personnel to answer questions or troubleshoot issues with the device.

For all PAP devices, the sleep test (Type I - IV, Other) must be interpreted by a physician who holds either:

1. Current certification in Sleep Medicine by the American Board of Sleep Medicine (ABSM); or,
2. Current subspecialty certification in Sleep Medicine by a member board of the American Board of Medical Specialties (ABMS); or,
3. Completed residency or fellowship training by an ABMS member board and has completed all the requirements for subspecialty certification in sleep medicine except the examination itself and only until the time of reporting of the first examination for which the physician is eligible; or,
4. Active staff membership of a sleep center or laboratory accredited by the American Academy of Sleep Medicine (AASM), Accreditation Commission for Health Care (ACHC), or The Joint Commission (TJC, formerly the Joint Commission on Accreditation of Healthcare Organizations – JCAHO).

**Continued Coverage beyond the First Three Months of Therapy**

Continued coverage of a PAP device (E0470 or E0601) beyond the first three months of therapy requires that, no sooner than the 31st day but no later than the 91st day after initiating therapy, the treating physician must conduct a clinical re-evaluation and document that the beneficiary is benefiting from PAP therapy.

For PAP devices, with initial dates of service on or after November 1, 2008, documentation of clinical benefit is demonstrated by:

1. Face-to-face clinical re-evaluation by the treating physician with documentation that symptoms of obstructive sleep apnea are improved; and,
2. Objective evidence of adherence to use of the PAP device, reviewed by the treating physician.

Adherence to therapy is defined as use of PAP ≥4 hours per night on 70% of nights during a consecutive thirty (30) day period anytime during the first three (3) months of initial usage. If the above criteria are not met, continued coverage of a PAP device and related accessories will be denied as not reasonable and necessary.

If the physician re-evaluation does not occur until after the 91st day but the evaluation demonstrates that the beneficiary is benefiting from PAP therapy as defined in criteria 1 and 2 above, continued coverage of the PAP device will commence with the date of that re-evaluation.
Beneficiaries who fail the initial 12 week trial are eligible to re-qualify for a PAP device but must have both:

1. Face-to-face clinical re-evaluation by the treating physician to determine the etiology of the failure to respond to PAP therapy; and,
2. Repeat sleep test in a facility-based setting (Type 1 study). This may be a repeat diagnostic, titration or split-night study.

If an E0601 device is tried and found ineffective during the initial facility-based titration or home trial, substitution of an E0470 does not change the length of the trial unless there is less than 30 days remaining in the trial period. If more than 30 days remain in the trial period, the clinical re-evaluation would still occur between the 31st and 91st day following the initiation of an E0601 and objective documentation of adherence on the E0470 would need to occur prior to the 91st day following initiation of the E0601. If less than 30 days remain in the trial period, the clinical re-evaluation and objective documentation of adherence must occur before the 120th day following the initiation of the E0601.

If an E0601 device was used for more than 3 months and the beneficiary was then switched to an E0470, the clinical re-evaluation must occur between the 31st and 91st day following the initiation of the E0470. There would also need to be documentation of adherence to therapy during the 3 month trial with the E0470.

If there is discontinuation of usage of a PAP device at any time, the supplier is expected to ascertain this and stop billing for the equipment and related accessories and supplies.

For a PAP device dispensed prior to November 1, 2008, if the initial Medicare coverage criteria in effect at the time were met and the criteria for coverage after the first 3 months that were in effect at the time were met, the device will continue to be covered for dates of service on or after November 1, 2008 as long as the beneficiary continues to use the device.

**Concurrent Use of Oxygen with Pap Therapy**

Some beneficiaries may require the simultaneous use of home oxygen therapy with a PAP device. To be considered for simultaneous coverage, all requirements in the Coverage Indications, Limitations and/or Medical Necessity for both Oxygen and Oxygen Equipment and Positive Airway Pressure (PAP) Devices for the Treatment of Obstructive Sleep Apnea LCDs must be met. Consequently, in addition to this LCD, suppliers should refer to the Oxygen and Oxygen Equipment LCD and related Policy Article for additional coverage, coding and documentation requirements.

Coverage of home oxygen therapy requires that the beneficiary be tested in the “chronic stable state.” Chronic stable state is a requirement of the National Coverage Determination (CMS Internet-only Manual, Pub. 100-3, Section 240.2) and is one of the key criteria when determining coverage for home oxygen therapy. The NCD defines chronic stable state as “…not during a period of an acute illness or an exacerbation of their underlying disease.” Based on this NCD definition, all co-existing diseases or conditions that can cause hypoxia must be treated and the beneficiary must be in a chronic stable state before oxygen therapy is considered eligible for payment. In addition, the beneficiary must have a severe lung disease, such as chronic obstructive pulmonary disease, diffuse interstitial lung disease, cystic fibrosis, bronchiectasis, widespread pulmonary neoplasm, or hypoxia-related symptoms or
findings that might be expected to improve with oxygen therapy (see Oxygen LCD for additional information). For beneficiaries with OSA to be considered in the chronic, stable state, OSA must be sufficiently treated such that the underlying severe lung disease is unmasked. This must be demonstrated before oxygen saturation results are considered qualifying for oxygen therapy.

For beneficiaries with OSA, a qualifying oxygen saturation test for the purposes of determining Medicare home oxygen reimbursement may only occur during a titration polysomnographic study (either split-night or stand-alone). The titration PSG is one in which all of the following criteria are met:

1. The titration is conducted over a minimum of two (2) hours; and,
2. During titration:
   A. The AHI/RDI is reduced to less than or equal to an average of ten (10) events per hour; or,
   B. If the initial AHI/RDI was less than an average of ten (10) events per hour, the titration demonstrates further reduction in the AHI/RDI; and,
3. Nocturnal oximetry conducted for the purpose for oxygen reimbursement qualification may only be performed after optimal PAP settings have been determined and the beneficiary is using the PAP device at those settings; and,
4. The nocturnal oximetry conducted during the PSG demonstrates an oxygen saturation ≤ 88% for 5 minutes total (which need not be continuous).

If all of the above criteria are met, for the purposes of a qualifying oxygen saturation test, the beneficiary is considered to be in the “chronic stable state.” To be eligible for Medicare coverage and payment for home oxygen therapy for concurrent use with PAP therapy, in addition to being in the chronic stable state, the beneficiary must meet all other coverage requirements for oxygen therapy.

Suppliers should refer to the Oxygen and Oxygen Equipment LCD and related Policy Article for additional coverage, coding and documentation requirements

For Medicare and Medicaid Determinations Related to States Outside of Nevada:
Please review Local Coverage Determinations that apply to other states outside of Nevada.
http://www.ems.hhs.gov/mcd/search

Important Note: Please also review local carrier Web sites in addition to the Medicare Coverage database on the Centers for Medicare and Medicaid Services’ Website.

DESCRIPTION OF SERVICES

Obstructive sleep apnea (OSA) is a breathing disorder that is defined by either a decrease or complete cessation of airflow during sleep. In OSA, airflow is obstructed when the muscles in the back of the throat fail to keep the airway open. Nocturnal respiration in patients with OSA is characterized by apnea (breathing cessation) and hypopnea (marked reduction in breathing volume). The signs and symptoms of untreated OSA include excessive daytime sleepiness, loud snoring, nocturnal choking, apneas or choking witnessed by bed partner, unrefreshing sleep, morning headaches, reduced libido and enuresis. Physiological effects of untreated OSA include fluctuating blood oxygen levels, increased heart rate, chronic daytime hypertension and impaired glucose tolerance/insulin resistance.
OSA can occur at one or more "levels" of the nasopharyngo-tracheal airway. Type I disease involves narrowing or collapse of the retropalatal region. Type II disease involves narrowing or collapse of both the retropalatal and retrolingual areas. Major OSA is usually a multi-level disorder, with tissues of the soft palate, lateral pharyngeal walls and tongue base all contributing to airway impingement. Intra-nasal tissue, adenoids and tonsils may also play a role (AASM, 2008).

Diagnosis and evaluation of sleep apnea syndrome is determined through polysomnography (PSG) or limited channel testing. Treatment for OSA includes lifestyle modifications (weight loss, avoidance of alcohol or other agents that decrease upper airway patency), positional therapy, positive airway pressure, oral appliance therapy and surgery. Positive airway pressure therapy may use any one of the following techniques: continuous positive airway pressure (CPAP), automatic positive airway pressure (APAP), bilevel positive airway pressure (BiPAP), variable positive airway pressure (VPAP).

Non-surgical oral appliances, worn during sleep, are intended to treat OSA by keeping the airway open in one of three ways: by pushing the lower jaw forward (a mandibular advancement device or MAD), by preventing the tongue from falling back over the airway (a tongue-retaining device) or by combining both mechanisms.

Oral appliances are recommended for treating OSA in ANY of the following circumstances:
- Mild OSA AND patient is unable to tolerate positive airway pressure (PAP) therapy OR refuses PAP
- Moderate to severe OSA as a component of treatment that includes additional modalities such as PAP therapy with reduced pressure
- As a standalone treatment for moderate to severe OSA, if patient is unable to tolerate PAP therapy OR refuses PAP, although this may not be the most effective therapy.

A nasal dilator is a removable appliance that is placed just inside the nostril and is secured in place with hypoallergenic adhesive. Using small valves, the device increases pressure inside the nose by creating resistance during exhalation to maintain an open airway during sleep (Theravent website).

There are a variety of surgical options used to treat OSA. The intention of surgery is to create a more open airway so obstructions are less likely to occur.

Implantable hypoglossal nerve stimulation systems are being evaluated as a way to relieve upper airway obstruction. There are two hypoglossal nerve stimulation systems that are being evaluated: the Inspire® Upper Airway Stimulation device (Inspire Medical) and the aura6000™ Sleep Therapy System (ImThera Medical). A third device, the HGNS System (Apnex Medical), has been discontinued and the manufacturer is no longer in business. The Inspire device is intended to treat moderate to severe obstructive sleep apnea (OSA) and is designed for use in patients who are unable or unwilling to use a CPAP device. Inspire’s construction and implantation are comparable to those of a pacemaker: a surgeon implants the device containing a neurostimulator subcutaneously in the patient’s chest with one lead attached to the patient’s hypoglossal nerve (cranial nerve XII) at the base of the tongue and one lead implanted in the patient’s chest. The lead in the chest consists of a pressure sensor that detects breathing. Information about respiration rate is relayed to the device, which stimulates the hypoglossal nerve in the tongue. When stimulated, the tongue moves forward, thus opening the airway. The patient can operate the device by remote control, which the patient activates before going to sleep. The device
turns on after 20 minutes to minimize disrupting the patient’s sleep onset; the device turns off via remote when the patient wakes.

**CLINICAL EVIDENCE**

**Nonsurgical Treatment**

**Oral Appliances**

An Agency for Healthcare Research and Quality (AHRQ) comparative effectiveness report states that despite no evidence or weak evidence on clinical outcomes, given the large magnitude of effect on the important intermediate outcomes of apnea-hypopnea index (AHI), Epworth Sleepiness Scale (ESS) and other sleep study measures, overall, the strength of evidence is moderate that mandibular advancement devices (MAD) are an effective treatment for OSA in patients without comorbidities (including periodontal disease) or excessive sleepiness. However, the strength of evidence is insufficient to address which patients might benefit most from treatment. The strength of evidence is insufficient regarding comparisons of different oral devices. Despite no evidence or weak evidence on clinical outcomes, overall the strength of evidence is moderate that the use of CPAP is superior to MAD. However, the strength of evidence is insufficient to address which patients might benefit most from either treatment. Comparative studies focusing on long-term follow-up and clinical outcomes are needed (Balk et al., 2011).

Bratton et al. (2015) compared the association of CPAP, MADs and inactive control groups (placebo or no treatment) with changes in systolic blood pressure and diastolic blood pressure in patients with OSA. A network meta-analysis was used to estimate pooled differences between each intervention. Of the 51 randomized studies included in the analysis (n=4888), 44 compared CPAP with an inactive control, 3 compared MADs with an inactive control, 1 compared CPAP with an MAD and 3 compared CPAP, MADs and an inactive control. Both CPAP and MADs were associated with reductions in blood pressure. Network meta-analysis did not identify a statistically significant difference between the blood pressure outcomes associated with these therapies.

In a randomized crossover trial, Phillips et al. (2013) compared the effects of continuous positive airway pressure (CPAP) and mandibular advancement device (MAD) therapy on cardiovascular and neurobehavioral outcomes in patients with obstructive sleep apnea (OSA). A total of 126 patients with moderate to severe OSA were randomly assigned to a treatment order, and 108 completed the trial with both devices. Health outcomes were similar after 1 month of treatment. CPAP was more efficacious than MAD in reducing AHI but compliance was higher with MAD. The 24-hour mean arterial pressure was not inferior on treatment with MAD compared with CPAP; however, overall, neither treatment improved blood pressure. Sleepiness, driving simulator performance and disease-specific quality of life improved on both treatments by similar amounts, although MAD was superior to CPAP for improving four general quality-of-life domains.

Holley et al. (2011) conducted a retrospective analysis evaluating the efficacy of an adjustable oral appliance (aOA) in comparison with continuous positive airway pressure (CPAP) for treating obstructive sleep apnea (OSA). A total of 497 patients were given an aOA. The aOA reduced the mean apnea-hypopnea index (AHI) to 8.4 ± 11.4, and 70.3%, 47.6% and 41.4% of patients with mild, moderate and severe disease achieved an AHI < 5, respectively. Patients using an aOA decreased their mean Epworth Sleepiness Score by 2.71 at follow-up. CPAP improved the AHI by -3.43 when
compared with an aOA, but when adjusted for severity of disease, this difference only reached significance for patients with severe disease (-5.88). However, 70.1% of all patients achieved an AHI < 5 using CPAP compared with 51.6% for the aOA. Baseline AHI was a significant predictor of achieving an AHI < 5, and age showed a trend toward significance. In comparison with past reports, more patients in this study achieved an AHI < 5 using an aOA. The authors concluded that aOAs are comparable to CPAP for patients with mild disease; however, CPAP is superior for patients with moderate to severe disease.

In a multicenter, randomized controlled trial (n=101), Lam et al. (2007) compared the effectiveness of three commonly used non-surgical treatment modalities in patients with mild to moderate OSA. Treatment groups consisted of conservative measures (sleep hygiene) only, continuous positive airways pressure (CPAP) in addition to conservative measures or an oral appliance in addition to conservative measures. The severity of sleep-disordered breathing was decreased in the CPAP and oral appliance groups compared with the conservative measures group, and the CPAP group was significantly better than the oral appliance group. Overall, CPAP produced the best improvement in terms of physiological, symptomatic and quality of life measures, while the oral appliance was slightly less effective.

A Cochrane review concluded that while CPAP appears to be more effective in improving sleep disordered breathing, there is increasing evidence suggesting that oral appliances (OA) improve subjective sleepiness and sleep disordered breathing compared with a control. Until there is more definitive evidence on the effectiveness of OA in relation to CPAP, with regard to symptoms and long-term complications, it would appear to be appropriate to recommend OA therapy to patients with mild symptomatic OSA, and those patients who are unwilling or unable to tolerate CPAP therapy. OA should not be considered as first choice therapy for OSA where symptoms and sleep disruption are severe (Lim et al., 2006; updated 2008).

Ferguson et al. (2006) conducted an evidence-based systematic review regarding the use of oral appliances for treating OSA and concluded that overall, patients with mild to severe OSA have a 52% chance of being able to control their sleep apnea using an appliance. Success rates ranged between 14 and 61% among patients with severe OSA (AHI defined as greater than 30 in some studies and great than 40 in others). Better success rates were seen in patients with lower AHI. OAs are on the whole less effective than CPAP but may be better accepted by patients than nasal CPAP in studies where subjects used both treatments. OAs are not recommended as a first line treatment in patients with severe OSA. However, these patients might consider an OA if they have failed CPAP or upper airway surgery, recognizing that the results of OA therapy in severe OSA are unpredictable. The literature now provides better evidence for the efficacy of OAs and indications for use.

Tegelberg et al. (2003) compared two different degrees of mandibular advancement with an intraoral appliance in 74 male patients with mild to moderate OSA. Thirty-eight patients received a dental appliance with 50% advancement and 36 patients received a dental appliance with 75% mandibular advancement. Somnography was performed pre-treatment and after one year of treatment. Fifty-five patients completed followup after one year of treatment. In the group of 50% advancement, normalization (an apnea index of <5 and apnea/hypopnea index <10) was observed in 79% of the group. In the group of 75% advancement, normalization was observed in 73% of the group. Less than 5% of the patients reported symptoms from the stomatognathic system; one-third of the patients
reported headaches more than once a week. Headaches significantly decreased after one year of treatment.

Thirty-five patients diagnosed with OSA unable to tolerate or non-compliant with CPAP were studied by Prathibha et al. (2003). These patients underwent sleep studies, used intraoral appliances for three months and had a repeat sleep study performed while using the appliance. Thirty-one patients completed the study. Patients with a pre-study AHI <20 benefited from the appliance, while the authors concluded that those patients with a pre-study AHI >20 did not.

Walker-Engstrom et al. (2002) randomized 95 patients with confirmed OSA to treatment with a dental appliance or uvulopalatopharyngoplasty. Patients underwent sleep studies before treatment and 1 year and 4 years after treatment. Thirty-two patients in the dental appliance group and 40 patients in the UPPP group completed the 4-year follow up. Success was defined as a reduction in the apnea index of at least 50%. The dental appliance group had a success rate of 81%; the UPPP group had a success rate of 53%. An apnea index of <5 or an apnea/hypopnea index <10 was observed in 63% of the dental-appliance group and 33% of the UPPP group. The compliance rate of the dental appliance group was 62%. Seventy-five percent of the UPPP group were satisfied with their results and required no further complementary treatment.

Gotsopoulus et al. (2002) evaluated the effect of a mandibular advancement splint (MAS) on daytime sleepiness and a range of other symptoms in 73 patients (59 men, 14 women) with mild to severe OSA. OSA severity subgroups revealed a predominance of moderate and severe OSA, with 41 patients (56%) and 21 patients (29%) in each subgroup, respectively. Using a randomized crossover design, patients received 4 weeks of treatment with MAS and a control device (inactive oral appliance). At the end of each treatment period, patients were reassessed by questionnaire, polysomnography, and multiple sleep latency tests. Participants experienced significantly improved mean sleep latency on the multiple sleep latency test and Epworth sleepiness scale score with the MAS compared with the control device. The proportion of patients with normal subjective sleepiness was significantly higher with the MAS than with the control device (82 versus 62%), but this was not so for objective sleepiness (48 versus 34%). Other OSA symptoms were controlled in significantly more patients with the MAS than with the control device.

In a randomized, controlled crossover study, Mehta et al. (2001) evaluated the efficacy of a mandibular advancement splint (MAS) in 28 patients with mild to severe OSA. Patients underwent three polysomnographs with either a control oral plate, which did not advance the mandible, or a MAS. Complete response (CR) was defined as a resolution of symptoms and a reduction in apnea/hypopnea index (AHI) to <5/hour, and partial response (PR) as a ≥ 50% reduction in AHI, but remaining ≥ 5/hour. Twenty-four patients (19 men, 5 women) completed the protocol. Treatment outcome was similar across all categories of OSA severity, with complete response being achieved in some subjects with moderate and severe OSA. Subjective improvements with the MAS were reported by the majority of patients (96%). There were significant improvements in AHI, oxygen saturation and arousal index with MAS, compared with the control. The control plate had no significant effect on AHI and oxygen saturation. CR (n = 9) or PR (n = 6) was achieved in 62.5% of patients. The MAS is an effective treatment in some patients with OSA, including those patients with moderate or severe OSA.
Nasal Dilators
Preliminary evidence suggests that use of the Provent nasal device significantly improves the apnea-hypopnea index (AHI) and some other OSA outcomes during short-term and mid-term use of the device in patients with mild, moderate and severe OSA, compared with baseline values. In addition, compared with a sham device, the improvements were more pronounced. Most of the studies evaluated short-term outcomes (~3 months). The therapeutic response to the Provent device varied among the patients, so it is unclear which factors are predictive of treatment response. There was some evidence that the use of the Provent device improved sleep quality and decreased daytime sleepiness among OSA patients, decreased the observed amount of snoring and had no effect on sleep architecture. The device was well tolerated and adherence to the device was high. Most adverse events were mild, such as nasal discomfort and dry mouth.

Despite these promising findings, the quality of the evidence was low. In several studies, patients served as their own controls. Sample sizes were small, and there were a fair number of dropouts. Additional limitations included the variable use of high- and standard-resistance devices, self-reported adherence data and a heterogeneous patient population. Overall, there is some evidence to suggest that the Provent nasal device is a safe and efficacious treatment for approximately half of the OSA patient population. However, independent randomized controlled trials are needed to evaluate the effectiveness of the device compared with established treatments for OSA, and to evaluate its long-term effectiveness. Additionally, a better understanding of the clinical profile of patients who most likely benefit from this therapy is required (Hayes, 2013; updated 2015).

In a randomized, partially blinded, placebo-controlled trial Rossi et al. (2013) evaluated the efficacy of the Provent nasal device for preventing the recurrence of obstructive sleep apnea (OSA) following continuous positive airway pressure (CPAP) withdrawal in patients with moderate-to-severe OSA. The goal of the study was to determine if OSA patients could occasionally substitute the Provent device for their CPAP. Sixty-seven patients with OSA receiving CPAP were randomized to one of three groups for 2 weeks: continuing CPAP (n=23), active Provent (n=22) or placebo Provent (n=22). The three groups were similar at baseline and their mean apnea-hypopnea index (AHI) before CPAP treatment was 38 events per hour. Primary outcomes included for the active Provent versus the placebo Provent were OSA severity (oxygen desaturation index (ODI)), AHI and Epworth Sleepiness Scale (ESS) score. Secondary outcomes for the active Provent versus the placebo Provent included ODI from ambulatory pulse oximetry and blood pressure (BP). For CPAP versus the active Provent or CPAP versus the placebo Provent, secondary outcomes included ODI/AHI, ESS and BP. OSA recurred in the active Provent and placebo Provent groups, and there was no significant difference in ODI, AHI and ESS between active Provent and placebo Provent at 2 weeks. ODI from ambulatory pulse-oximetry and BP at 2 weeks were not different in the active Provent versus the placebo Provent groups. ODI, AHI and BP, but not ESS, were significantly higher in the active Provent and placebo Provent groups compared with CPAP. The authors concluded that Provent cannot be recommended as an alternative short-term therapy for patients with moderate to severe OSA already on CPAP.

Berry et al. (2011) conducted a multicenter randomized controlled trial investigating the efficacy of a nasal expiratory positive airway pressure (EPAP) device for treating OSA. Two hundred and fifty patients with mild to severe OSA were randomized to treatment with EPAP (n=127) or a similar sham device (n=123) for 3 months. A total of 229 completed week 1 sleep studies (119 EPAP, 110 sham). This group was the intention to treat (ITT) group. Of these, 173 had an AHI > 5/hour on the device-off
night and comprised the modified intention to treat (mITT) group (92 EPAP, 81 sham). One hundred ninety five patients in the ITT group (100 EPAP, 95 sham) and 144 patients in the mITT group (77 EPAP, 67 sham) completed the 3 month study. All patients underwent a baseline clinic evaluation that included the Epworth Sleepiness Scale (ESS). Polysomnography (PSG) was performed on 2 non-consecutive nights (random order: device-on, device-off) at week 1 and after 3 months of treatment. At week 1, the EPAP device significantly decreased the AHI compared to device-off nights and the difference was significantly greater than with the sham device (52.7% versus 7.3%, ITT analysis). At 3 months, 51% of the EPAP device users had a 50% or greater reduction in the AHI on device-on compared to device-off nights. The authors concluded that nasal EPAP significantly reduced the AHI and improved subjective daytime sleepiness compared to the sham treatment in patients with mild to severe OSA with excellent adherence. This study is limited by short follow-up, patient-reported adherence, a large number of exclusion criteria and a modified intention to treat group. A potential for bias exists due to manufacturer sponsorship of the study.

Kryger et al. (2011) conducted a 13 center extension study of the 3-month Berry trial. This study was designed to evaluate the long-term effectiveness of EPAP. Forty-one patients from the EPAP arm who met adherence and efficacy criteria were continued on therapy and returned for polysomnography (PSG) after 12 months of treatment. From the analyzable subject cohort (n=34), results from the 12 month PSGs were compared against their baseline results. Median AHI was reduced from 15.7 to 4.7 events/h (week 1 device-off versus month 12 device-on). The decrease in the AHI (median) was 71.3%. The Epworth Sleepiness Scale decreased from 11.1 ± 4.2 to 6.0 ± 3.2. The median percentage of reported nights used (entire night) was 89.3%. The authors reported that long-term adherence to EPAP was excellent in those who had a positive clinical response at month 3 of the Berry trial. As with the original trial, this study is limited by patient-reported adherence, a large number of exclusion criteria and a modified intention to treat group. A potential for bias exists due to manufacturer sponsorship of the study.

Patel et al. (2011) studied a one way nasal device using EPAP to identify appropriate patients for the therapy and provide pilot data as to its potential mechanisms of action. Twenty patients with OSA underwent three nocturnal polysomnograms (NPSG) including diagnostic, therapeutic (with a Provent® nasal valve device) and CPAP. Nineteen of the 20 patients tolerated the device. The authors reported that the nasal valve device produced improvement in sleep disordered breathing in 75% of patients with OSA of varying severity, with 50% of patients reaching a clinically significant reduction in RDI. Although the study was not able to establish predictors of success or a definitive mechanism of action, the authors feel it helps define a restricted list of candidates for further investigation. A potential for bias exists due to manufacturer sponsorship of the study.

Walsh et al. (2011) evaluated tolerability, short-term efficacy and adherence of an EPAP nasal device in 59 OSA patients who refused CPAP or used CPAP less than 3 hours per night. After demonstrating tolerability to the EPAP device during approximately 1 week of home use, 47 patients (80%) underwent a baseline polysomnogram (PSG1). Forty-three patients met AHI entry criteria and underwent PSG2 within 10 days of PSG1. Twenty four patients (56%) met prespecified efficacy criteria and underwent PSG3 after 5 weeks of EPAP treatment. Compared to PSG1, mean AHI was significantly lower at both PSG2 and PSG3. For most patients AHI at PSG3 was similar to AHI at PSG2. Device use was reported an average of 92% of all sleep hours. The authors concluded that improvements in AHI and Epworth Sleepiness Scale (ESS) scores, combined with the high degree of
treatment adherence observed, suggest that the EPAP device tested may become a useful therapeutic option for OSA. Limitations of the study include lack of randomization and control, small sample size and short term follow-up. A potential for bias exists due to manufacturer sponsorship of the study.

In a multicenter, prospective study, Rosenthal et al. (2009) evaluated the efficacy of a novel device placed in the nares that imposes an expiratory resistance for the treatment of OSA and evaluated adherence to the device over a 30-day in-home trial period. Participants (n=34) with a baseline apnea-hypopnea index (AHI) ≥ 5 were evaluated. Treatment was well tolerated and accepted by the participants. The authors documented an overall reduction in AHI; however, therapeutic response was variable (and at times inconsistent) among the participants. Further research is required to identify the ideal candidates for this new therapeutic option in the management of OSA. A potential for bias exists due to manufacturer sponsorship of the study.

Colrain et al. (2008) conducted a pilot study to test the hypothesis that the application of expiratory resistance via a nasal valve device would improve breathing during sleep in subjects with OSA and in primary snorers. Thirty men and women were recruited for the study. Twenty-four had at least mild OSA (AHI >5), and 6 were primary snorers. Subjects underwent 2 nights of polysomnographic evaluation, one with and one without a new nasal resistance device with the order of nights counterbalanced across participants. The device consisted of a small valve inserted into each nostril calibrated to provide negligible inspiratory resistance, but increased expiratory resistance. Standard polysomnography was conducted to compare participants' sleep both with and without the device, with the scoring conducted blind to treatment condition. The apnea-hypopnea (AHI) and oxygen desaturation (O2DI) indices both significantly decreased, and the percentage of the night spent above 90% saturation significantly increased with device use. The results of this pilot study are suggestive of a therapeutic effect of expiratory nasal resistance for some OSA patients and indicate that this technique is worthy of further clinical study. A potential for bias exists due to manufacturer sponsorship of the study.

Professional Societies
American Academy of Sleep Medicine (AASM)
AASM makes the following recommendations regarding oral appliance therapy (Ramar et al., 2015):

- When oral appliance therapy is prescribed by a sleep physician for an adult patient with OSA, the guidelines suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices. Strength of recommendation: Guideline. Quality of evidence: Low. Benefits clearly outweigh harms.
- Sleep physicians should consider prescription of oral appliances, rather than no treatment, for adult patients with OSA who are intolerant of CPAP therapy or prefer alternate therapy. Strength of recommendation: Standard. Quality of evidence: Moderate. Benefits clearly outweigh harms.
- Qualified dentists should provide oversight, rather than no follow-up, of oral appliance therapy in adult patients with OSA to survey for dental-related side effects or occlusal changes and reduce their incidence. Strength of recommendation: Guideline. Quality of evidence: Low. Benefits clearly outweigh harms.
- Sleep physicians should conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances. Strength of recommendation: Guideline. Quality of evidence: Low. Benefits clearly outweigh harms.
• Sleep physicians and qualified dentists should instruct adult patients treated with oral appliances for OSA to return for periodic office visits, as opposed to no follow-up, with a qualified dentist and a sleep physician. Strength of recommendation: Guideline. Quality of evidence: Low. Benefits clearly outweigh harms.

AASM practice parameters on the treatment of central sleep apnea do not list oral appliances as a treatment option (Aurora et al., 2012).

American College of Physicians (ACP)
The ACP developed a clinical practice guideline on the management of obstructive sleep apnea (OSA) in adults based on an AHRQ systematic review (Balk, et al., 2011). The guideline makes the following recommendations:

• All overweight and obese patients diagnosed with OSA should be encouraged to lose weight. (Grade: strong recommendation; low-quality evidence)

• Continuous positive airway pressure treatment is recommended as the initial therapy for patients diagnosed with OSA. (Grade: strong recommendation; moderate-quality evidence)

• Mandibular advancement devices as an alternative therapy to continuous positive airway pressure treatment is recommended for patients diagnosed with OSA who prefer mandibular advancement devices or for those with adverse effects associated with continuous positive airway pressure treatment. (Grade: weak recommendation; low-quality evidence) (Qaseem et al., 2013).

European Respiratory Society (ERS)
An ERS report on non-CPAP therapies for OSA concluded that evidence supports the use of mandibular advancement devices in mild to moderate OSA. Nasal dilators cannot be recommended as effective treatments for OSA (Randerath et al., 2011).

Surgical Treatment
An Agency for Healthcare Research and Quality (AHRQ) comparative effectiveness review concluded that CPAP remains the most effective treatment for OSA. The studies for surgical interventions are limited, and current evidence is insufficient to determine their relative effectiveness when compared to each other, to sham or no treatment or to other OSA interventions (Balk et al., 2011).

Caples et al. (2010) conducted a systematic review and meta-analysis of literature reporting outcomes following various upper airway surgeries for the treatment of OSA in adults, including maxillomandibular advancement (MMA), pharyngeal surgeries such as uvulopalatopharyngoplasty (UPPP), laser assisted uvulopalatoplasty (LAUP) and radiofrequency ablation (RFA), as well as multi-level and multi-phased procedures. The authors found that the published literature is comprised primarily of case series, with few controlled trials and varying approaches to pre-operative evaluation and postoperative follow-up. Surgical morbidity and adverse events were reported but not systematically analyzed. The change in the apnea-hypopnea index (AHI) was the primary measure of efficacy. Substantial and consistent reductions in the AHI were observed following MMA; adverse events were uncommonly reported. Outcomes following pharyngeal surgeries were less consistent; adverse events were reported more commonly. Papers describing positive outcomes associated with newer pharyngeal techniques and multi-level procedures performed in small samples of patients appear promising. Further research is needed to better clarify patient selection, as well as efficacy and safety of upper airway surgery in those with OSA.
In a Cochrane review, Sundaram and Lasserson (2005; reviewed 2008) evaluated surgical treatment for obstructive sleep apnea. Ten studies (602 participants) of mixed quality met the inclusion criteria. Data from eight studies were eligible for assessment in the review. No data could be pooled. The authors concluded that there are now a small number of trials assessing different surgical techniques with inactive and active control treatments. The studies assembled in the review do not provide evidence to support the use of surgery in sleep apnea/hypopnea syndrome, as overall significant benefit has not been demonstrated. The participants recruited to the studies had mixed levels of AHI, but tended to suffer from moderate daytime sleepiness where this was measured. Short-term outcomes are unlikely to consistently identify suitable candidates for surgery. Long-term follow-up of patients who undergo surgical correction of upper airway obstruction is required. This would help to determine whether surgery is a curative intervention, or whether there is a tendency for the signs and symptoms of sleep apnea to re-assert themselves, prompting patients to seek further treatment for sleep apnea.

**Uvulopalatopharyngoplasty (UPPP)**

Using conventional surgical instruments, UPPP removes excess tissue from the soft palate and pharynx. The tonsils are also removed if present (ASAA, 2015).

One RCT evaluated UPPP versus lateral pharyngoplasty for OSA hypopnea syndrome (OSAHS). This study found that lateral pharyngoplasty provided statistically significant improvements in daytime sleepiness and apnea-hypopnea index compared with UPPP; however, it was small (n=27) and involved a mean of only 8 months of follow-up (Cahali, 2004).

Wilhelmsson et al. (1999) conducted the largest study (n=95), with follow-up data provided in three other articles (Walker-Engstrom 2000; 2002, Ringqvist 2003). This RCT, which evaluated UPPP versus nonsurgical treatment with a mandibular advancement device, provides limited evidence that the mandibular advancement device is more effective than UPPP. Patients randomized to the device had significant improvements in apnea index, apnea-hypopnea index, and blood oxygen saturation, relative to patients randomized to UPPP. However, 38% of patients in the device treatment group were lost to follow-up or withdrew from the study due to noncompliance before 4 years of follow-up were completed.

Another RCT of UPPP was conducted by Lojander et al. (1996), who performed two parallel RCTs in which patients were assigned to CPAP (n=44) or UPPP (n=32) by a team of medical experts and then randomized to treatment or no treatment. Although the results of this study suggest that UPPP and CPAP reduced symptoms of sleep apnea, the design of this study prevents direct comparison of results obtained with UPPP versus CPAP. Considering only the UPPP arm of the trial, this procedure was found to provide statistically significant improvements in daytime sleepiness and snoring but not in decreases in blood oxygen saturation levels during sleep.

In a nonrandomized comparative study, Walker et al. (1997) investigated the efficacy and safety of UPPP (n=41) compared with LAUPP (n=38). The response rate, defined as a > 50% reduction in the postoperative respiratory disturbance index, was 51% of UPPP-treated patients and 47% of LAUPP-treated patients. Patients in the UPPP group had higher respiratory disturbance indexes prior to surgery (52.1) compared with those who underwent LAUPP (30.3), which may have had an impact on outcome.
Maxillomandibular Advancement Surgery (MMA) / Multilevel Surgery (MLS)

MMA is a procedure in which both the upper (maxillary) and lower (mandible) jaws are cut and reconfigured. GAHM is a procedure in which the tongue is advanced by cutting the chin bone and moving the chin forward. Then the hyoid bone is fixed to the mandible or thyroid cartilage. These procedures are intended to expand the airway and reduce OSA.

Most of the published literature addressing maxillomandibular advancement (MMA) surgery for treatment of obstructive sleep apnea (OSA) is of case series design. The variety of surgical techniques used, combinations of treatment, and patient selection criteria presents some difficulty in comparison of results. Additionally, variation in what was termed as outcome success inhibits comparison of results.

In a meta-analysis and systematic review of the clinical efficacy and safety of MMA in treating OSA, Holty et al. (2010) found that the mean apnea-hypopnea index (AHI) decreased from 63.9/h to 9.5/h following surgery. The pooled surgical success and cure (AHI <5) rates were 86.0% and 43.2%, respectively. Younger age, lower preoperative weight, lower AHI and greater degree of maxillary advancement were predictive of increased surgical success. Most patients reported satisfaction after MMA with improvements in quality of life measures and most OSA symptoms. The authors concluded that MMA is a safe and highly effective treatment for OSA.

Lin et al. (2008) conducted a systematic review and meta-analysis on outcomes in patients with sleep apnea/hypopnea syndrome (OSAHS) treated with multilevel surgery of the upper airway. After applying specific inclusion criteria, 49 multilevel surgery articles (58 groups) were identified including 1,978 patients. The mean minimal follow-up time was 7.3 months. Success was defined as a reduction in the apnea/ hypopnea index (AHI) of 50% or more and an AHI of less than 20. The success rate was 66.4%, and the overall complication rate was 14.6%. The authors noted that while multilevel surgery for OSAHS is associated with improved outcomes, this clinical advantage is supported largely by level 4 evidence (case series without an internal control group). Future research should focus on prospective and controlled studies.

In a prospective, nonrandomized comparative study, Dattilo and Drooger (2004) assigned 57 patients with OSA to MMA surgery (n=15) or palatal surgery combined with genioglossus advancement and hyoid suspension (n=42). Daytime sleepiness scores decreased 72% after MMA versus 43% after the palatal and other procedures. Parallel improvements were seen in respiratory disturbance index, which decreased 83% after MMA versus 59% after the other procedures. Although these results suggest that MMA surgery is more effective than palatal surgery with genioglossus advancement and hyoid suspension, the statistical significance of differences between the treatment groups at baseline and after treatment was not reported.

Vilaseca et al. (2002) treated 20 patients with UPPP plus mandibular osteotomy with GAHM and concluded that patients with mild and moderate OSA and multilevel obstruction in the upper airway may benefit from UPPP plus GAHM. Mean AHI was reduced from 60.5 to 44.6. CT90 (percentage of time with oxyhemoglobin saturation below 90%) decreased from 39.5% to 25.1%. The overall surgical success rate was 35% but increased to 57% in patients with moderate OSAS and to 100% in mild OSA. In the group of severe OSA, the success rate was only 9%.
Riley et al. presented the results of several studies evaluating maxillomandibular surgery to treat OSA. There may be some overlap in the study populations reported. One of the early studies, published in 1989, reported a case series of patients with snoring, excessive daytime sleepiness (EDS), and OSA documented by polysomnography (PSG). Fifty-five patients underwent inferior sagittal osteotomy (ISO) and uvulopalatopharyngoplasty (UPPP). "Responder" was defined as a respiratory distress index of < or = 20 and an RDI reduction of at least 50%, and a normal oxygen saturation. The mean preoperative RDI was 58.7, and postoperatively was 11.8; mean presurgical O2 saturation was 71.5, and postsurgically 87.1. Postoperative PSG showed that 67% (n=37/ 55) of patients with ISO were responders, 80% had a reduction of more than 50% of apnea index (AI). Improvement in hypertension, and subjective improvement in snoring and memory was reported. For patients receiving maxillomandibular advancement surgery, mean presurgical RDI was 67.8, and postsurgically was 9.3; preoperative O2 saturation was 65.9% and postoperatively, 87.2% (still below normal, but markedly improved.). All 25 patients reported subjective improvement in snoring and excessive daytime sleepiness.

Riley reported on another series of 40 patients who had failed anterior mandibular osteotomy (AMO) with or without uvulopalatopharyngoplasty, underwent MMA. Patients had fiberoptic pharyngoscopy, cephalometric radiographs and PSG prior to MMA and at 6 months postoperatively. Success was defined as an RDI of < 20 with at least a 50% reduction in respiratory events and a normal O2 saturation. Presurgical RDI was reported as 66.8 and postsurgical, 9.1. Surgical success was reported for 97% of patients; of the 18 patients who had used nasal continuous positive airway pressure (CPAP) preoperatively, all reported that MMA was equally effective. Despite a reported 20% mandibular relapse rate, OSA was reported as controlled in that group. The investigators concluded that MMS was as effective as CPAP in treating OSA (Riley, 1990a).

A second series of 30 patients was reported on in 1990b. This group of 30 consecutive patients with OSA had failed to comply with CPAP treatment and had hypopharyngeal-retrolingual obstruction with or without oropharyngeal-palatal obstruction. Twenty-five of the thirty patients underwent UPPP, and all 30 patients underwent MMA. Pretreatment RDI was 72.0, on-CPAP RDI was 8.6, and post-treatment RDI was 8.8. Marked improvement is O2 saturation was reported postoperatively. At 6-month follow-up, all patients reported marked improvement in excessive daytime sleepiness and 93% reported that snoring was controlled. No statistical difference was found between treatment with CPAP and surgical treatment with MMA or MMA plus UPPP.

A 1993 study by Riley et al., reported on a large case series of 415 OSA patients (although only 306 patients completed the study). Patients received tiered therapy: patients with soft palate obstruction received UPPP; patients with retrolingual obstruction had MMA; patients with retrolingual and soft palate obstruction received genioglossal advancement with hyoid myotomy, and finally, patients who did not improve with UPPP or genioglossal advancement with hyoid myotomy, were offered MMA. Success was defined as PSG results equivalent to a two-night baseline CPAP or RDI < 20 with at least a 50% reduction in RDI, and O2 saturation levels comparable to those while on CPAP. Mean presurgical RDI was 55.8, on CPAP was 7.4, and post-surgical was 9.2 Eighty-one percent of patients reported marked improvement in EDS, 78% reported snoring was controlled. The overall reported success rate was 76.5%. Sixty-one percent of patients having UPPP or genioglossal advancement with hyoid myotomy had successful results; 97% of patients undergoing MMA were reported as having successful results. The authors concluded that there was no significant difference in success between
CPAP and surgery. They reported a 95% long-term success rate with the staged surgical process.

Most recently, in 2000, Riley reported on a case series of 40 patients treated between 1985 and 1995, to report long-term results of MMA with genioglossus and hyoid advancement. Success was reported as improvement in snoring, EDS, and PSG data comparable to that found with CPAP or postoperative RDI < 20 with a 50% reduction from presurgical level and O2 saturation equivalent to that found with CPAP. Ninety percent (n=36/40) of patients were determined to have long-term success. A major shortcoming of this report, however, is that the method of patient selection for inclusion was not reported.

Neruntarat (2003a) studied the short term results of genioglossus advancement and hyoid myotomy with suspension in 31 patients with OSA. Six to 8 months post-surgery, the mean RDI decreased from 48.2 (+/- 10.8) to 14.5 (+/- 5.8). The lowest oxygen saturation increased from 81.8% (+/- 3.8) to 88.8% (+/- 2.9). Responders were defined as patients who had a reduction in RDI of at least 50% and an RDI of less than 20 after surgery. Using these criteria, 70% of the patients responded to the surgery.

Neruntarat (2003b) reported the long term results of genioglossus advancement and hyoid myotomy with suspension in 46 patients with OSA. The mean pre-operative RDI was 47.9 (+/-8.4). The follow-up time ranged from 37 to 46 months. The mean RDI at follow-up was 18.6 (+/- 4.1).

Lee et al. (1999) published results of a prospective study of 48 patients with OSA. Patients with nasal obstruction underwent nasoseptoplasty or treatment with nasal corticosteroid; then had UPPP and anterior mandibular osteotomy (AMO) or inferior sagittal osteotomy (ISO). Patients then were evaluated by PSG at 4-6 months, and those who were non-responders were given MMA (n=3). "Responder" was defined as an exhibitor of an RDI < 20 and with an O2 saturation > 95%. Thirteen patients did not complete the trial. Sixty-four percent (n=24/35) of patients were responders to UPPP and AMO or ISO. All three patients receiving MMA responded to the treatment. The authors concluded that, in a properly selected patient population, staged reconstruction of the airway is efficacious.

A study by Prinsell et al. (1999), reviewed the cases of 50 patients with OSA by PSG (RDI > 15, O2 saturation < 90%, and EDS) and with orohypopharyngeal narrowing caused by macroglossia with retropositioned tongue base, who underwent MMA. Success was defined by the authors as: RDI < 15, O2 saturation > 80%, and apnea index (AI) < 5, OR a reduction in RDI and AI > 60% and an AI < 10. Findings were that all patients reported elimination of EDS, and that there was significant improvement in RDI, AI, O2 saturation, number of desaturations, blood pressure, BMI and sleep parameters. The authors concluded that surgery produced results comparable to use of CPAP.

Hochban et al. (1997) reported on 38 patients with an RDI of > 20 who underwent MMA with a goal of 10 mm of maxillary and mandibular advancement. Twenty-four of thirty-eight patients accepted a 3-month course of CPAP prior to surgery. All but one patient experienced a reduction in RDI to < 10 and subjective symptoms were resolved in all patients.

Conradt et al. (1997) reported on a small prospective study of 15 patients with EDS and RDI > 20. Patients were offered a three-month trial of CPAP prior to surgery, and then MMA with a goal of 10
mm maxillary and mandibular advancement. Preoperative RDI/AI were 51.4/33.6, on-CPAP 3.9/1.0, at 6-12 weeks postoperative, 5.0/2.3, and at 2 years postoperative 8.5/1.3.

There remains a moderate amount of disagreement over patient selection, with some proponents recommending advancement of 10 mm up to 15 mm to achieve functional effect. There is also some disagreement over the order of staging procedures, though the generally accepted order of intervention is to progress from least-invasive to most-invasive (Coleman, 1999).

Radiofrequency Ablation of the Soft Palate and/or Tongue
Radiofrequency tissue volume reduction (RFTVR) involves the use of low-intensity radiofrequency energy to shrink the size of the uvula, soft palate and/or tongue. Somnoplasty™ and Coblation® are two trade names using this technology. The procedure may be performed in conjunction with other therapies.

A meta-analysis by Farrar et al. (2008) looked at sixteen studies using radiofrequency ablation (RFA) to treat OSA. The study found a 31% reduction in short-term Epworth Sleepiness Scale (ESS), which was maintained beyond 12 months. RFA resulted in a 31% reduction in short term and a 45% reduction in long-term respiratory disturbance index (RDI) levels. Short-term results of the lowest O2 saturations failed to demonstrate improvement. The authors concluded that RFA seems to be a clinically effective tool that reduces ESS scores and RDI levels in patients with OSA syndrome. However, the design of included studies was unclear. The majority of studies appeared to be observational and lacked a control group. The review methodology was poorly reported and no assessment of the methodological quality of included studies was reported. Included studies had small sample sizes and mainly short-term follow-up.

Results of a randomized placebo-controlled trial comparing RFTVR and sham RFTVR of the tongue base, or tongue base and palate, with nasal CPAP suggested that CPAP provided somewhat better results, since AI and AHI scores were lower when CPAP was used. However, these benefits were obtained only if patients complied adequately with CPAP treatment. Data obtained with the FOSQ and the ESS suggested that CPAP and RFTVR provided comparable improvements in OSA (Woodson 2003). Although upper airway RFTVR and CPAP were also found to provide comparable benefits in a small retrospective case-matched comparative trial and a prospective nonrandomized comparative study, none of the studies evaluating RFTVR versus CPAP involved any follow-up after the post-treatment assessment (Woodson, 2001; Steward, 2004). Therefore, it is not known if RFTVR provided durable benefits.

Franklin et al. (2009) conducted a systematic review evaluating the efficacy and adverse effects of surgery for OSA. The authors reported that only a small number of randomized controlled trials with a limited number of patients assessing some surgical modalities for sleep apnea are available. For RFA, the studies reviewed did not support any benefit on daytime sleepiness, apnea reduction or quality of life.

Two reviewed studies compared RFTVR of the palate and uvula and LAUPP in a randomized design. Although results of one study suggested that these two procedures provided similar benefits, the statistical significance of differences between the RFTVR and LAUPP groups was not reported (Atef, 2005). In addition, the second study was small (n=17) and indicated that both RFTVR (palate) and
LAUPP reduced snoring but did not significantly reduce other symptoms of mild sleep-disordered breathing (Terris, 2002a). In one randomized study, RFTVR of palate and uvula was compared to radiofrequency channeling (Bassiouny, 2007). Both methods were equally effective at 4 months post-treatment, the date of the final follow-up. Both methods significantly improved snoring and OAS. However, there was a nonsignificant trend that RFTVR may achieve improvements faster and may have a higher success and cure rates for OAS (50% and 45%, respectively) than the channeling method (40% and 25%, respectively). It is not known whether the treatment effect can be maintained beyond the 4 months follow-up.

Hofmann et al. (2006) compared temperature controlled RFTVR to conventional surgery using a non-randomized comparative design. Both UPPP and RFTVR reduced snoring, but UPPP led to improvement in AHI and HI, while RFTVR did not. While postoperative pain was shorter in duration for RFTVR, the number of treatments was higher, leading to a comparable length of postoperative pain.

**Laser-Assisted Uvulopalatoplasty (LAUP)**

Two of the reviewed studies were randomized trials that evaluated LAUPP. Ferguson et al. (2003) conducted a small RCT (n=45) with 8 months of follow-up to evaluate LAUPP versus no treatment for mild OSA. Although patients who underwent an average of 2.4 LAUPP procedures had statistically significant improvements in snoring and apnea-hypopnea index relative to the control group, improvements in daytime sleepiness and sleep apnea QOL scores were not statistically significant. Moreover, the benefits were limited, corresponding to a 44% decrease in mean snoring intensity and 35% decrease in apnea-hypopnea index.

Terris et al. (2002a) also conducted a randomized trial of LAUPP but used a randomized crossover design in which patients were randomly assigned to LAUPP or RFA of the palate and then allowed to undergo the nonassigned treatment if their assigned treatment did not provide adequate improvement. Although this study was small (n=17) and involved only 16 weeks of follow-up, the results suggest that multiple LAUPP and RFA treatments of the palate reduce snoring but do not significantly reduce the other symptoms of sleep-disordered breathing such as daytime sleepiness or upper airway collapse.

An RCT conducted by Larrosa et al. (2004) focused primarily on LAUPP for treatment of snoring; however, it included some patients with mild OSA and evaluated outcomes other than snoring intensity. Patients were randomized to LAUPP or a placebo surgery control group. This study was small (n=25) and did not involve any follow-up after the post treatment assessment at 3 months; however, it found that there were no statistically significant differences between the control group and LAUPP treatment group in snoring, daytime sleepiness, apnea-hypopnea index, or QOL measures. A shortcoming of the trial is that patients underwent only one LAUPP treatment rather than the multiple treatments provided by Terris and Ferguson.

In addition to these RCTs, one nonrandomized comparative study investigated the efficacy and safety of LAUPP (n=38) compared with UPPP (n=41) (Walker, 1997). The response rate, defined as a > 50% reduction in the postoperative respiratory disturbance index, was 47% of LAUPP-treated patients and 51% of UPPP-treated patients. Patients in the LAUPP group had lower respiratory disturbance indexes prior to surgery (30.3) compared with those who underwent UPPP (52.1), which may have affected treatment outcomes.
Lysdahl et al. (2002) compared the outcomes of 121 patients treated for rhonchopathy, the majority of whom also reported apneas. Sixty-one were treated with uvulopalatopharyngoplasty and 60 with laser-assisted uvulopalatoplasty. The patients were requested to assess the frequency of symptoms associated with OSA prior to surgery, at 3-month follow up and 5 to 8 years postoperatively. Both groups reported significant improvements; however UPPP was superior to LAUPP in terms of all clinical effect parameters. However, the surgeries are not directly comparable as more tissue is removed in UPPP, and the OSA was self-reported.

Lin et al. (2006) conducted a prospective, controlled trial in which they evaluated LAUPP as treatment for moderately severe or severe OSA in 25 subjects. After LAUPP, impedance in non-responders remained elevated, but impedance in responders returned to levels comparable to those in the 15 healthy controls.

**Palatal Implants**

Palatal implants consist of three small woven polyester inserts that are placed in the soft palate to stiffen the palate and thereby reduce the number of episodes of partial or complete blockage of breathing during sleep. Pillar® is a trade name using this technology. The woven consistency of the polyester inserts is designed to facilitate an inflammatory response that results in the formation of a fibrous capsule surrounding each insert (Pillar website).

Choi et al. (2013) performed a meta-analysis of studies evaluating the efficacy of the Pillar implant for treating mild to moderate obstructive sleep apnea (OSA). Seven studies were included: 5 case series (n=287) and 2 controlled trials (n=76). Mean follow-up duration ranged from 3 to 29 months. The Pillar implant significantly reduced the Epworth Sleepiness Scale and the apnea-hypopnea index (AHI) compared to pre-procedure values. The authors concluded that the Pillar implant has a moderate effect on mild to moderate OSA, but acknowledged that most of the relevant studies were case series and not placebo-controlled. Most studies were also limited by short-term follow-up.

In a randomized, double-blind, placebo-controlled trial (n=22), Maurer et al. (2012) assessed the effects of palatal implants in patients with mild to moderate sleep apnea due to palatal obstruction. Respiratory parameters and sleep efficiency (evaluated by polysomnography), snoring (evaluated by the bed partner) and daytime sleepiness (evaluated by ESS) were assessed before and 90 days after surgery. The apnea-hypopnea index (AHI), hypopnea index (HI) and lowest oxygen saturation (LSAT) showed statistically significant improvement in the treatment group. Snoring as rated by bed partners also showed statistically significant improvement within the treatment group. There was no statistical difference when comparing the means of the treatment group with the placebo group. There were no peri- or postoperative complications and no extrusions during the follow-up period. The study supports the idea that palatal implants lead to a reduction in respiratory events in patients with mild to moderate OSA, although a statistically significant superiority of palatal implants over placebo could not be demonstrated in this trial. In addition, the significance of this study is limited by extremely small sample size.

A National Institute for Health and Care Excellence (NICE) guideline states that current evidence on soft-palate implants for obstructive sleep apnea (OSA) raises no major safety concerns, but there is inadequate evidence that the procedure is efficacious in the treatment of this potentially serious condition for which other treatments exist. Therefore, soft-palate implants should not be used in the
treatment of OSA (NICE, 2007).

Friedman et al. (2008) performed a double-blinded, placebo-controlled RCT that enrolled 62 patients with mild-to-moderate OSA who underwent palatal implantation (Treatment Group, n=31) or mock implantation (Control Group, n=31). In the patients who completed 3 months of follow-up, mean AHI scores had decreased from 24 to 16 points for the Treatment Group versus an increase from 20 to 21 (1 4) points for the Control Group. Although improvements were statistically significant, they were relatively small.

In a multi-institution, double-blind, placebo-controlled study, Steward et al. (2008) randomly assigned one hundred patients with mild to moderate OSA and suspected retropalatal obstruction to treatment with three palatal implants or sham placebo. Palate implants demonstrated efficacy over placebo for several important outcomes measures with minimal morbidity, but overall effectiveness remains limited. The investigators concluded that further study is needed.

In a retrospective, nonrandomized, controlled study, Friedman et al. (2006a) evaluated the Pillar implant system alone and in combination with other procedures for treatment of mild-to-moderate OSA/hypopnea syndrome (OSAHS). A total of 125 patients (mean age 42 11 years) who had mild-to-moderate OSAHS were assigned to palatal implantation alone (Palatal Group, n=29), or in combination with other procedures. Most of the procedures other than palatal implantation were not defined clearly. After a mean follow-up of 8 1 months, mean AHI for the Palatal Group had decreased from 13 8 to 12 13; however, this difference was not statistically significant compared with baseline. Using the criteria of AHI < 20 and > 50% reduction of AHI as "cured," Friedman reported that 7 (24%) Palatal Group patients and 43 (34%) of all patients were "cured." A serious shortcoming of this conclusion is that many patients had an AHI < 20 at baseline, particularly in the Palatal Group, which had a baseline AHI of 13 8.

Walker et al. (2006) studied the Pillar implant system in 53 patients in a 90 day multicenter noncomparative study. Inclusion criteria were OSA caused by palatal obstruction, an AHI score of 10 to 30, a BMI less than or equal to 32 kg/m2, age greater than or equal to 18 years, and a soft palate of sufficient length for the implants. Mean AHI score decreased from 25 14 at baseline to 22 15 at 90 days follow-up. Although this decrease was small, it was statistically significant (P=0.05). The AHI score was reduced to below 10 in 12 (23%) patients; however, 18 (34%) patients experienced an increase in their AHI score.

Three other small, uncontrolled studies have been performed to evaluate the Pillar Palatal Implant System for mild-to moderate OSA. These studies enrolled 16 to 26 patients who had an AHI score of 5 to 30. These studies reported that, compared with baseline, patients obtained small-to-moderate but statistically significant improvements in outcomes such as AHI and Epworth Sleepiness Scale (ESS) scores at up to 1 year of follow-up; however, these studies do not provide reliable evidence of efficacy since they did not involve any control or comparison groups (Friedman, 2006b; Goessler, 2007; Nordgard, 2007).

**Lingual Suspension/Tongue Fixation**

Lingual suspension is intended to keep the tongue from falling back over the airway during sleep. This procedure involves inserting a bone screw into the lower jaw. A cable is then threaded through the base
of the tongue and anchored to the bone screw. It is usually performed in conjunction with other procedures. No studies on the long-term success of this procedure are available, and there is little clinical data to demonstrate its efficacy.

Handler et al. (2014) performed a systematic review of suture-based tongue suspension procedures as a stand-alone therapy for hypopharyngeal obstruction in obstructive sleep apnea (OSA). The review also compared outcomes of tongue suspension as part of various multilevel approaches to OSA surgery. Studies published after 1997 were included and involved four cohorts: tongue suspension alone, tongue suspension with uvulopalatopharyngoplasty (UPPP), tongue suspension with genioglossus advancement (GA) plus UPPP and tongue suspension with genioglossus advancement with hyoid suspension (GAHM) plus UPPP. Twenty-seven studies were included. Six studies qualified for the tongue suspension-alone group with a surgical success rate of 36.6%. Eight studies qualified for the cohort of tongue suspension with UPPP with a surgical success rate of 62.3%. Eighteen studies qualified for the remaining two cohorts: GA plus UPPP and GAHM plus UPPP. The surgical success rates for both were 61.1%. Surgical outcomes were similar among the various combined procedures. Author noted limitations include the inability to measure statistical significance due to lack of patient demographic data for the individual studies. Secondly, of the studies used to create the surgical cohorts, three were level 2 evidence, while the remaining 24 were considered level 4 evidence. Lastly, some studies used pre- and postoperative respiratory distress index (RDI), while others used the apnea-hypopnea index (AHI), making comparisons difficult.

In a multicenter, prospective case series, Woodson et al. (2010) assessed the safety and effectiveness of an adjustable lingual suspension device (Advance System) for treating OSA. Forty two surgically naive patients with moderate to severe OSA and tongue base obstruction underwent surgical insertion of a midline tissue anchor into the posterior tongue and connected to an adjustable mandibular bone anchor with a flexible tether. Outcomes included changes in AHI, sleepiness, sleep-related quality-of-life, snoring, swallowing, speech and pain. After six months, all patients noted improvement for AHI, sleepiness and sleep-related quality of life. Post implant pain scores were mild to moderate at day one and resolved by day five. Device related adverse events included wound infection (7%) and edema or seroma (5%), which resolved. However, in 31 percent of patients, asymptomatic tissue anchor barb fractures were observed radiographically. The tissue anchor failure rate of the tested device precludes its clinical use. Further investigation is warranted.

Kuhnel et al. (2005) conducted a prospective nonrandomized study (n=28) to demonstrate the efficacy of tongue base suspension with the Repose™ System in the treatment of OSA. PSG was performed before as well as three and 12 months after surgery. Lateral cephalometric radiography and videoendoscopy of the pharynx were performed preoperatively and postoperatively to identify morphological changes in the posterior airway space. A suspension suture anchored intraorally at the mandible was passed submucosally in the body of the tongue, with suture tightness adjusted individually. The posterior airway space was widened by at least 2 mm in 60% of cases. Daytime sleepiness improved subjectively in 67% of patients, and the RDI improved postoperatively in 55% of patients. The correlation between posterior airway space widening and the improvements in daytime sleepiness and respiratory disturbance index was not significant. The authors concluded that surgical intervention in obstructive sleep apnea syndrome with the Repose™ System does not result in permanent anatomical change in the posterior airway space.
Miller et al. (2002) conducted a retrospective analysis of the Repose System for the treatment of OSA to describe preliminary experience using the system in conjunction with UPPP in the multilevel surgical approach. The authors evaluated 19 consecutive patients undergoing UPPP and the Repose™ System tongue base suspension for the management of OSA during a one-year period (1998 through 1999). Fifteen patients had complete preoperative and postoperative PSG data. A 46% reduction in RDI was demonstrated at a mean of 3.8 months after surgery. The apnea index demonstrated a 39% reduction. The authors concluded that the Repose™ System in conjunction with UPPP has been shown to produce significant reductions in the RDI and apnea index, as well as a significant increase in oxygen saturation. Despite the improvement in these objective parameters, the overall surgical cure rate was only 20% (three of 15 patients) in this retrospective series. Further research is warranted to define the role of the Repose™ System in the management of obstructive sleep apnea patients.

Woodson et al. (2000) conducted a prospective multicenter uncontrolled study to evaluate the feasibility and short-term subjective effectiveness of a new tongue suspension technique using the Repose™ System in 39 patients with snoring and OSA. Twenty-three patients completed 1 month and 19 completed 2 months of follow-up. In OSA patients, activity level, energy/fatigue, and sleepiness improved. Two-month outcomes were less (activity level, energy/fatigue, and sleepiness). Fewer changes were observed in snorers than in OSA patients. There were 6 complications (18%), including sialadenitis (4), gastrointestinal bleeding (1), and dehydration (1) after the procedure. Authors concluded that further evaluation is required to demonstrate effectiveness.

DeRowe et al. (2000) performed minimally invasive technique for tongue-base suspension with the Repose™ system in 16 patients with sleep-disordered breathing. Fourteen patients reported an improvement in daytime sleepiness, and their bed partners reported an improvement in snoring. The mean respiratory distress index before surgery was 35. Two months after surgery, the mean respiratory distress index was 17, an improvement of 51.4%. These preliminary results show the initial efficacy and safety of this new surgical procedure.

Transoral Robotic Surgery (TORS)
Based on studies using TORS to treat head and neck cancers, researchers are investigating the use of this technology for patients with obstructive sleep apnea.

Justin et al. (2016) conducted a systematic review of the literature evaluating the effectiveness, complications and safety of TORS for the treatment of OSA. Sixteen studies were included. TORS was almost always combined with other sleep surgery procedures. The summary estimate of the decrease in AHI using TORS as part of a multilevel surgical approach was 24.0. The summary estimate of a decrease in ESS score was 7.2 and of the overall surgical "success" (defined as AHI <20 and 50% reduction) was 48.2%. Three large studies reported complication rates with an average of 22.3%. The authors concluded that initial results for the use of TORS as part of a multilevel surgical approach for OSA are promising for select patients. However, the morbidity may be greater than with other techniques, offsetting its advantages in visualization and precision. More prospective studies are needed to determine the optimal role of this tool.

In a prospective, nonrandomized trial using historical controls, Lee et al. (2012) assessed the use of transoral robot-assisted lingual tonsillectomy and uvulopalatopharyngoplasty for the surgical management of tongue base obstruction in patients with obstructive sleep apnea. Twenty patients have
completed the study to date. The rate of surgical success was 45%, and the rate of surgical response was 65%. The mean preoperative apnea-hypopnea index of 55.6 decreased by 56.7%, to a mean postoperative value of 24.1, and the minimum arterial oxygen saturation increased from the mean preoperative value of 75.8% to the mean postoperative value of 81.7%. The mean Epworth Sleepiness Scale score improved from 13.4 to 5.9. One patient had postoperative bleeding that required cauterization, resulting in a major complication rate of 4.2%. This study is limited by lack of randomization and small sample size.

Friedman et al. (2012) assessed the feasibility and efficacy of robotically assisted partial glossectomy without tracheotomy by comparing obstructive sleep apnea-hypopnea syndrome (OSAHS) outcomes with those of established techniques. Using a historical cohort study, 40 consecutive patients underwent transoral robotic surgery (TORS) for OSAHS and were followed up with regard to complications, morbidity and subjective and objective outcomes. Data from 27 of these patients who underwent concomitant z-palatoplasty with 6-month follow-up were compared with those of 2 matched cohorts of patients who underwent either radiofrequency or coblation reduction of the tongue base and z-palatoplasty. No major bleeding or airway complications were observed. Postoperative pain and length of admission were similar between groups. All groups saw Epworth score and snore score improvement. Patients undergoing robot-assisted surgery took longer than their radiofrequency counterparts to tolerate normal diet and resume normal activity. Apnea hypopnea index (AHI) reduction averaged 60.5% ± 24.9% for TORS versus 37.0% ± 51.6% and 32.0% ± 43.3% for coblation and radiofrequency, respectively. Only the robotic group achieved statistically significant improvement in minimum oxygen saturation. Surgical cure rate for TORS (66.7%) was significant compared with radiofrequency (20.8%) but not compared with coblation (45.5%). The authors concluded that it is feasible to perform robotically assisted partial glossectomy without the need for tracheotomy. This technique resulted in greater AHI reduction but increased morbidity compared with the other techniques studied. This study is limited by a retrospective design and small sample size.

Vicini et al. (2010) evaluated the feasibility, tolerability and efficacy of tongue base management using transoral robotic surgery (TORS) in patients with obstructive sleep apnea-hypopnea syndrome (OSAHS). Seventeen patients with OSAHS, principally related to tongue base hypertrophy, underwent TORS (Intuitive da Vinci®). Patients with a minimum follow-up of 3 months were evaluated. Ten patients [mean preoperative apnea-hypopnea index (AHI): 38.3 +/- 23.5 SD] were included in the study. The postoperative polysomnographic results were fairly good (mean postoperative AHI: 20.6 +/- 17.3 SD), and the functional results (pain, swallowing and quality of life) were encouraging. Complications were rare and of minor importance. Transoral robotic tongue base management in patients with OSAHS primarily related to tongue base hypertrophy is feasible and well tolerable. The authors found these preliminary results encouraging and worthy of further evaluation.

**Hypoglossal Nerve Stimulation**

A Hayes report concluded that the overall quality of the evidence evaluating hypoglossal nerve stimulation for treating OSA is very low. Stimulation of the hypoglossal nerve may provide a treatment option for patients with moderate-to-severe OSA for whom CPAP has failed to provide relief, but the procedure may carry risks for complications and postimplantation surgical procedures. The evidence is still unclear as to whether improvements translate to better sleep quality and improved quality of life. Additional good-quality comparative studies with larger sample sizes are needed to define the patient population that is most likely to respond to this therapy option (Hayes, 2016).
Certal et al. (2015) conducted a systematic review and meta-analysis evaluating the safety and efficacy of hypoglossal nerve stimulation in the treatment of OSA. Six prospective studies (n=200) were included in the review. At 12 months, the pooled data demonstrated statistically significant reductions in AHI, ODI and ESS. Similar reductions were observed at 3 and 6 months. Overall, the AHI was reduced between 50% and 57%, and the ODI was reduced between 48% and 52%. Despite using different hypoglossal nerve stimulators in each subgroup analysis, no significant heterogeneity was found in any of the comparisons, suggesting equivalent efficacy regardless of the system in use. The authors concluded that hypoglossal nerve stimulation therapy may be considered in selected patients with OSA who fail medical treatment; however, further studies comparing this therapy with conventional therapies are needed to definitively evaluate outcomes.

The Stimulation Therapy for Apnea Reduction (STAR) trial (Strollo et al. 2014) evaluated the clinical safety and effectiveness of upper airway stimulation at 12 months for the treatment of moderate to severe obstructive sleep apnea. Using a multicenter, prospective, single-group, cohort design, an upper-airway stimulation device was surgically implanted in patients with obstructive sleep apnea who had difficulty either accepting or adhering to CPAP therapy. The primary outcome measures were the apnea-hypopnea index (AHI; the number of apnea or hypopnea events per hour, with a score of $\geq 15$ indicating moderate-to-severe apnea) and the oxygen desaturation index (ODI; the number of times per hour of sleep that the blood oxygen level drops by $\geq 4$ percentage points from baseline). Secondary outcome measures were the Epworth Sleepiness Scale, the Functional Outcomes of Sleep Questionnaire (FOSQ), and the percentage of sleep time with the oxygen saturation less than 90%. The study included 126 participants; 83% were men. The mean age was 54.5 years, and the mean body-mass index (the weight in kilograms divided by the square of the height in meters) was 28.4. The median AHI score at 12 months decreased 68%, from 29.3 events per hour to 9.0 events per hour; the ODI score decreased 70%, from 25.4 events per hour to 7.4 events per hour. Secondary outcome measures showed a reduction in the effects of sleep apnea and improved quality of life. In the randomized phase, the mean AHI score did not differ significantly from the 12-month score in the nonrandomized phase among the 23 participants in the therapy-maintenance group (8.9 and 7.2 events per hour, respectively); the AHI score was significantly higher (indicating more severe apnea) among the 23 participants in the therapy-withdrawal group (25.8 vs. 7.6 events per hour). The ODI results followed a similar pattern. The rate of procedure-related serious adverse events was less than 2%. The authors concluded that upper-airway stimulation led to significant improvements in objective and subjective measurements of the severity of obstructive sleep apnea. The lack of a control group limits the validity of the results of this study. This study was funded by Inspire Medical Systems.

Follow-up studies of the same patient population at 18 and 36 months, indicate that the treatment effects are maintained over time. Limitations are the same as the original study (Strollo et al., 2015; Woodson et al., 2016).

In a subgroup analysis of the STAR trial, Woodson et al. (2014) assessed the efficacy and durability of upper airway stimulation via the hypoglossal nerve on obstructive sleep apnea (OSA) severity including objective and subjective clinical outcome measures. The study included a consecutive cohort of 46 responders at 12 months from a prospective phase III trial of 126 implanted participants. Participants were randomized to either therapy maintenance ("ON") group or therapy withdrawal ("OFF") group for a minimum of 1 week. Short-term withdrawal effect as well as durability at 18 months of primary (apnea hypopnea index and oxygen desaturation index) and secondary outcomes
(arousal index, oxygen desaturation metrics, Epworth Sleepiness Scale, Functional Outcomes of Sleep Questionnaire, snoring, and blood pressure) were assessed. Both the therapy withdrawal group and the maintenance group demonstrated significant improvements in outcomes at 12 months compared to study baseline. In the randomized assessment, therapy withdrawal group returned to baseline, and therapy maintenance group demonstrated no change. At 18 months with therapy on in both groups, all objective respiratory and subjective outcome measures showed sustained improvement similar to those observed at 12 months. The authors concluded that withdrawal of therapeutic upper airway stimulation results in worsening of both objective and subjective measures of sleep and breathing, which when resumed results in sustained effect at 18 months. The authors state that reduction of obstructive sleep apnea severity and improvement of quality of life were attributed directly to the effects of the electrical stimulation of the hypoglossal nerve. The author-reported limitations of this study include the selection bias of only including responders to upper airway stimulation device therapy and the lack of subject or investigator blinding. This study was funded by Inspire Medical Systems.

In a prospective uncontrolled study, Van de Heyning et al. (2012) examined the safety and preliminary effectiveness of a second generation device, the Upper Airway Stimulation (UAS) system, and identified baseline predictors for therapy success. UAS systems were implanted in patients with moderate to severe OSA who failed or were intolerant of continuous positive airway pressure (CPAP). The study was conducted in 2 parts. In part 1, patients were enrolled with broad selection criteria. Apnea hypopnea index (AHI) was collected using laboratory-based polysomnography at preimplant and postimplant visits. Epworth Sleepiness Scale (ESS) and Functional Outcomes of Sleep Questionnaire (FOSQ) were also collected. In part 2, patients were enrolled using selection criteria derived from the experience in part 1. In part 1, 20 of 22 enrolled patients (two exited the study) were examined for factors predictive of therapy response. Responders had both a body mass index ≤32 and AHI ≤50 and did not have complete concentric palatal collapse. Part 2 patients (n = 8) were selected using responder criteria and showed an improvement on AHI from baseline, from 38.9 ± 9.8 to 10.0 ± 11.0 at 6 months postimplant. Both ESS and FOSQ improved significantly in part 1 and 2 subjects. According to the authors, this study demonstrates that therapy with upper airway stimulation is safe and efficacious in a select group of patients with moderate to severe OSA who cannot or will not use CPAP as primary treatment. Limitations of this study included lack of control group and small sample size. The investigators acknowledged that the different implantation techniques and eligibility criteria used in the 2 parts of the study hampered interpretation of the study results. The study was funded by Inspire Medical Systems.

In a small prospective uncontrolled study, Vanderveken et al. (2013) evaluated the possible predictive value of drug-induced sleep endoscopy (DISE) in assessing therapeutic response to implanted upper airway stimulation (UAS) for obstructive sleep apnea (OSA). The authors reported on the correlation between DISE results and therapy response in 21 OSA patients (apnea-hypopnea index [AHI] 38.5 ± 11.8/h; body mass index [BMI] 28 ± 2 kg/m(2), age 55 ± 11 y, 20 male/1 female) who underwent DISE before implantation of a UAS system. Statistical analysis revealed a significantly better outcome with UAS in patients (n = 16) without palatal complete concentric collapse (CCC), reducing AHI from 37.6 ± 11.4/h at baseline to 11.1 ± 12.0/h with UAS. No statistical difference was noted in AHI or BMI at baseline between the patients with and without palatal CCC. In addition, no predictive value was found for the other DISE collapse patterns documented. The authors concluded that the absence of palatal CCC during DISE may predict therapeutic success with implanted UAS therapy but additional studies are needed. The study was funded by Inspire Medical Systems.
Mwenge et al. (2012) studied targeted hypoglossal neurostimulation (THN) therapy with the aura6000™ System. The primary objective was to improve the polysomnographically determined apnea/hypopnea index (AHI) at 3 months, and maintain the improvement after 12 months of treatment. Thirteen out of 14 operated patients were successfully implanted. At 12 months, the AHI decreased from 45±18 to 21±17, a 53% reduction. The 4% oxygen desaturation index fell from 29±20 to 15±16 and the arousal index from 37±13 to 25±14. The Epworth sleepiness scale decreased from 11±7 to 8±4. THN was neither painful nor awakened patients, who all complied with therapy. There were two transient tongue paresis. The authors concluded that THN is safe and effective to treat OSA in patients not compliant with CPAP. The small sample size and lack of a control group compromises the validity of the results of this study.

Schwartz et al. (2012) hypothesized that graded increases in hypoglossal nerve stimulation (HGNS) relieve pharyngeal obstruction progressively during sleep. Responses were examined in 30 patients with sleep apnea who were implanted with an HGNS system. Current (milliamperes) was increased stepwise during non-REM sleep. Frequency and pulse width were fixed. At each current level, stimulation was applied on alternating breaths, and responses in maximal inspiratory airflow (V(I)max) and inspiratory airflow limitation (IFL) were assessed. The authors found that HGNS produced marked dose-related increases in airflow without arousing patients from sleep. Increases in airflow were of sufficient magnitude to eliminate IFL in most patients and IFL and non-IFL subgroups achieved normal or near-normal levels of flow, suggesting potential HGNS efficacy across a broad range of sleep apnea severity. According to the authors, further studies in additional patients, sleep stages, and body positions are required to determine the clinical and physiologic predictors of this response.

Professional Societies

**American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS)**

No evidence-based clinical practice guidelines addressing the treatment of OSA were identified. The organization has published several position statements related to OSA treatment options; however, these documents are based on an informal process of expert or committee consensus (AAO-HNS website).

**American Academy of Sleep Medicine (AASM)**

The AASM recommends surgery as a treatment option for OSA when noninvasive treatments such as CPAP or oral appliances have been unsuccessful. It is most effective when there is an obvious anatomic deformity that can be corrected to alleviate the breathing problem. Otherwise, surgical options most often address the problem by reducing or removing tissue from the soft palate, uvula, tonsils, adenoids or tongue. More complex surgery may be performed to adjust craniofacial bone structures. Surgical options may require multiple operations, and positive results may not be permanent. The AASM did not address the use of hypoglossal nerve stimulation as a therapeutic option (AASM, 2008).

A 2010 AASM practice parameter (Aurora, 2010a; Aurora, 2010b; Caples, 2010) on surgical options for OSA makes the following recommendations:

- **Uvulopalatopharyngoplasty (UPPP):** UPPP as a single surgical procedure, with or without tonsillectomy, does not reliably normalize the AHI when treating moderate to severe OSA. Therefore, patients with severe OSA should initially be offered positive airway pressure (PAP) therapy, while those with moderate OSA should initially be offered either PAP therapy or oral
appliances. The clinical evidence for UPPP is very low quality (Option recommendation – either inconclusive or conflicting evidence or conflicting expert opinion). This recommendation is a change from the previous practice parameter.

- **Maxillomandibular Advancement (MMA) Surgery**: MMA is indicated for surgical treatment of severe OSA in patients who cannot tolerate or who are unwilling to adhere to PAP therapy, or in whom oral appliances, which are more often appropriate in mild and moderate OSA patients, have been considered and found ineffective or undesirable. Although the clinical evidence is very low quality, studies tend to demonstrate consistent effectiveness in severe OSA. MMA is not well described in mild and moderate OSA making recommendations in less severe OSA unclear (Option recommendation – either inconclusive or conflicting evidence or conflicting expert opinion).

- **Multi-Level or Stepwise Surgery (MLS)**: Multi-level surgery, as a combined procedure or as stepwise multiple operations, is acceptable in patients with narrowing of multiple sites in the upper airway, particularly when UPPP as a sole treatment has failed (Option recommendation – either inconclusive or conflicting evidence or conflicting expert opinion).

- **Radiofrequency Ablation (RFA)**: RFA can be considered as a treatment in patients with mild to moderate OSA who cannot tolerate or who are unwilling to adhere to positive airway pressure therapy, or in whom oral appliances have been considered and found ineffective or undesirable. The clinical evidence for RFA is very low quality (Option recommendation – either inconclusive or conflicting evidence or conflicting expert opinion).

- **Laser-Assisted Uvulopalatoplasty (LAUP)**: LAUP is not routinely recommended as a treatment for OSA syndrome. LAUP does not generally normalize the AHI and the literature does not demonstrate significant improvement in secondary outcomes. Some studies actually saw worsening of the overall AHI. The clinical evidence for LAUP is low quality. (Standard recommendation – generally accepted patient-care strategy).

- **Palatal Implants**: Palatal implants may be effective in some patients with mild obstructive sleep apnea who cannot tolerate or who are unwilling to adhere to positive airway pressure therapy, or in whom oral appliances have been considered and found ineffective or undesirable. There is limited research that adequately assesses the efficacy of palatal implants for the treatment of OSA. Available studies suggest marginal efficacy (Option recommendation – either inconclusive or conflicting evidence or conflicting expert opinion).

**American Sleep Apnea Association (ASAA)**

While positive airway pressure therapy is the first line of treatment for moderate to severe sleep apnea, patient compliance represents a problem. For the noncompliant patient, surgery may be a feasible alternative. The surgeon must first determine what part of the upper airway is causing the obstruction to airflow. The sites of obstruction could be anywhere in the upper respiratory tract including the nose, tongue and throat.

There are many surgical options for the treatment of sleep apnea for patients who cannot tolerate CPAP therapy. Because the airway pattern and the severity of obstruction vary greatly between individuals, the surgical regimen must be catered to a particular individual. Often it takes a combination of procedures to achieve success. A logical step-wise approach must be taken when a patient seeks surgery, and it is a requisite that the patient finds a surgeon who understands both the pathophysiology of sleep apnea and the anatomy of the upper respiratory tract to ensure the best chance of success (ASAA, 2015).
**European Respiratory Society (ERS)**
An ERS report on non-CPAP therapies for OSA concluded that maxillomandibular osteotomy seemed to be as efficient as CPAP in patients who refused conservative treatment. Radiofrequency tonsil reduction, tongue base surgery, uvulopalatal flap, laser midline glossectomy, tongue suspension and genioglossus advancement cannot be recommended as single interventions. Uvulopalatopharyngoplasty, palatal implants and hyoid suspension should only be considered in selected patients and potential benefits should be weighed against the risk of long-term side-effects. Multilevel surgery is only a salvage procedure for OSA patients (Randerath et al., 2011).

**U.S. FOOD AND DRUG ADMINISTRATION (FDA)**

Oral appliances for OSA are regulated by the FDA, but products are too numerous to list. See the following website for more information (use product codes LRK or LQZ). Available at: [http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm](http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm). Accessed April 2017.


Radiofrequency ablation (RFA) systems for surgery are regulated by the FDA as Class II devices, and a large number of these RFA systems have been approved via the 510(k) process. The following devices are among the RFA devices specifically approved for coagulation of tissues in the head and neck.

- The Somnoplasty™ System, manufactured by Olympus (formerly Gyrus ENT), received 510(k) approval (K982717) from the FDA on November 2, 1998. Intended for the reduction of the incidence of airway obstructions in patients suffering from upper airway resistance syndrome (URAS) or obstructive sleep apnea syndrome (OSAS), the system generates heat for creating finely controlled lesions at precise locations within the upper airway. As the tissue heals it reduces tissue volume, opening the airway. Available at: [http://www.accessdata.fda.gov/cdrh_docs/pdf/K982717.pdf](http://www.accessdata.fda.gov/cdrh_docs/pdf/K982717.pdf). Accessed April 2017.

- Coblation® technology, manufactured by ArthroCare ENT, received 510(k) approval (K030108) from the FDA on February 3, 2003. The system is a bipolar, high frequency electrosurgical system indicated for ablation, resection and coagulation of soft tissue and hemostasis of blood vessels in otorhinolaryngology (ENT) surgery. Using low temperatures, the technology destroys tissue using radiofrequency energy to excite electrolytes in a conductive medium, such as saline. Available at: [http://www.accessdata.fda.gov/cdrh_docs/pdf3/K030108.pdf](http://www.accessdata.fda.gov/cdrh_docs/pdf3/K030108.pdf). Accessed April 2017.

The AIRvance™ Tongue Suspension system (formerly Repose™), manufactured by Medtronic ENT, received 510(k) approval (K981677) from the FDA on August 27, 1999. The system is intended for anterior tongue base suspension by fixation of the soft tissue of the tongue base to the mandible bone using a bone screw with pre-threaded suture. It is also suitable for the performance of a hyoid procedure. It is indicated for the treatment of OSA and/or snoring. Available at: [http://www.accessdata.fda.gov/cdrh_docs/pdf/K981677.pdf](http://www.accessdata.fda.gov/cdrh_docs/pdf/K981677.pdf). Accessed April 2017.
The Pillar® System for treating obstructive sleep apnea, manufactured by Medtronic ENT, received 510(k) approval (K040417) from the FDA on July 28, 2004. The system of palatal implants is intended to stiffen the soft palate tissue, which may reduce the incidence of upper airway obstruction in patients suffering from mild to moderate OSA. Available at: http://www.accessdata.fda.gov/cdrh_docs/pdf4/K040417.pdf. Accessed April 2017.

The FDA granted premarket approval (PMA) on April 30, 2014, to the Inspire Upper Airway Stimulation (UAS) system (Inspire Medical Systems Inc.) (P130008), which includes the Model 3024 Implantable Pulse Generator, the Model 4063 Stimulation Lead, the Model 4323 Sensing Lead, the Model 2740 Physician Programmer, and the Model 3032 Patient Programmer for treatment of patients with an AHI ≥ 20 and ≤ 65. Inspire UAS is used in adult patients ≥ 22 years of age who have been confirmed to fail or cannot tolerate PAP treatments such as CPAP or BPAP machines, and who do not have a complete concentric collapse at the soft palate level. The device is also referred to as the Inspire II (search MNQ in the Product Code field at: 510(k) Premarket Notification Database). The FDA mandated 2 post-approval studies: a prospective, single-arm cohort study to evaluate the long-term safety of the device in 124 subjects over 5 years, and a multicenter, prospective, single-arm cohort study to evaluate long-term safety and effectiveness of the device and effectiveness of the physician training program in 127 subjects over 5 years. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfTopic/pma/pma.cfm?num=P130008. Accessed April 2017.

Additional product information
Advance System (Aspire Medical) is an adjustable tongue base suspension system that is not yet FDA approved for marketing in the U.S.

Aura6000 (ImThera Medical) is an implantable hypoglossal nerve stimulation system that is not yet FDA approved for marketing in the U.S.

APPLICABLE CODES

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Coverage Determination Guidelines may apply.

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<td>0467T</td>
<td>Revision or replacement of chest wall respiratory sensor electrode or electrode array, including connection to existing pulse generator</td>
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<td>Removal of chest wall respiratory sensor electrode or electrode array</td>
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<td>Reconstruction of mandibular rami, horizontal, vertical, C, or L osteotomy; without bone graft</td>
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<tr>
<td>21194</td>
<td>Reconstruction of mandibular rami, horizontal, vertical, C, or L osteotomy; without bone graft</td>
</tr>
<tr>
<td>CPT® Code</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>21195</td>
<td>Reconstruction of mandibular rami and/or body, sagittal split; without internal rigid fixation</td>
</tr>
<tr>
<td>21196</td>
<td>Reconstruction of mandibular rami and/or body, sagittal split; with internal rigid fixation</td>
</tr>
<tr>
<td>21198</td>
<td>Osteotomy, mandible, segmental;</td>
</tr>
<tr>
<td>21199</td>
<td>Osteotomy, mandible, segmental; with genioglossus advancement</td>
</tr>
<tr>
<td>21206</td>
<td>Osteotomy, maxilla, segmental (eg, Wassmund or Schuchard)</td>
</tr>
<tr>
<td>21685</td>
<td>Hyoid myotomy and suspension</td>
</tr>
<tr>
<td>41512</td>
<td>Tongue base suspension, permanent suture technique</td>
</tr>
<tr>
<td>41530</td>
<td>Submucosal ablation of the tongue base, radiofrequency, 1 or more sites, per session</td>
</tr>
<tr>
<td>41599</td>
<td>Unlisted procedure, tongue, floor of mouth</td>
</tr>
<tr>
<td>42145</td>
<td>Palatopharyngoplasty (eg, uvulopalatopharyngoplasty, uvulopharyngoplasty)</td>
</tr>
<tr>
<td>42299</td>
<td>Unlisted procedure, palate, uvula</td>
</tr>
<tr>
<td>64553</td>
<td>Percutaneous implantation of neurostimulator electrode array; cranial nerve</td>
</tr>
<tr>
<td>64568</td>
<td>Incision for implantation of cranial nerve (eg, vagus nerve) neurostimulator electrode array and pulse generator</td>
</tr>
<tr>
<td>64569</td>
<td>Revision or replacement of cranial nerve (eg, vagus nerve) neurostimulator electrode array, including connection to existing pulse generator</td>
</tr>
<tr>
<td>64570</td>
<td>Removal of cranial nerve (eg, vagus nerve) neurostimulator electrode array and pulse generator</td>
</tr>
</tbody>
</table>

*CPT® is a registered trademark of the American Medical Association.*

<table>
<thead>
<tr>
<th>HCPCS Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0485</td>
<td>Oral device/appliance used to reduce upper airway collapsibility, adjustable or non-adjustable, prefabricated, includes fitting and adjustment</td>
</tr>
<tr>
<td>E0486</td>
<td>Oral device/appliance used to reduce upper airway collapsibility, adjustable or non-adjustable, custom fabricated, includes fitting and adjustment</td>
</tr>
<tr>
<td>L8679</td>
<td>Implantable neurostimulator, pulse generator, any type</td>
</tr>
<tr>
<td>L8680</td>
<td>Implantable neurostimulator electrode, each</td>
</tr>
<tr>
<td>L8686</td>
<td>Implantable neurostimulator pulse generator, single array, non-rechargeable, includes extension</td>
</tr>
<tr>
<td>S2080</td>
<td>Laser-assisted uvulopalatoplasty (laup)</td>
</tr>
</tbody>
</table>

**REFERENCES**


Obstructive Sleep Apnea Treatment.


May;146(5):854-62.


The foregoing Health Plan of Nevada/Sierra Health & Life Health Operations protocol has been adopted from an existing UnitedHealthcare coverage determination guideline that was researched, developed and approved by the UnitedHealthcare Coverage Determination Committee.