Medical Policy

Blue Cross Blue Shield Blue Care Network of Michigan

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Title: Obstructive Sleep Apnea and Snoring - Surgical Treatment

Description/Background

Obstructive sleep apnea (OSA) is characterized by repetitive episodes of upper airway obstruction due to the collapse and obstruction of the upper airway during sleep.
The hallmark symptom of OSA is excessive daytime sleepiness, and the typical clinical sign of OSA is snoring, which can abruptly cease and be followed by gasping associated with a brief arousal from sleep. The snoring resumes when the patient falls back to sleep, and the cycle of snoring/apnea/arousal may be repeated as frequently as every minute throughout the night. Sleep fragmentation associated with the repeated arousal during sleep can lead to impairment of daytime activity. For example, adults with OSA-associated daytime somnolence are thought to be at higher risk for accidents involving motorized vehicles (i.e., cars, trucks, heavy equipment). OSA in children may result in neurocognitive impairment and behavioral problems. In addition, OSA affects the cardiovascular and pulmonary systems. For example, apnea leads to periods of hypoxia, alveolar hypoventilation, hypercapnia, and acidosis. This in turn can cause systemic hypertension, cardiac arrhythmias, and cor pulmonale. Systemic hypertension is common in patients with OSA. Severe OSA is associated with decreased survival, presumably related to severe hypoxemia, hypertension, or an increase in automobile accidents related to overwhelming sleepiness.

There are racial and ethnic health disparities seen for OSA, impacting the prevalence of disease and accessibility to treatment options, particularly affecting children. Black children are 4 to 6 times more likely to have OSA than white children. [1] Among young adults 26 years of age or younger, African American individuals are 88% more likely to have OSA compared to white individuals. Another study found that African American individuals 65 years of age and older were 2.1 times more likely to have severe OSA than white individuals of the same age group. These health disparities may affect accessibility to treatment for OSA and impact health outcomes. One analysis of insurance claims data, including over 500,000 patients with a diagnosis of OSA, found that increased age above the 18- to 29- year range ($p<.001$) and Black race ($p=.020$) were independently associated with a decreased likelihood of receiving

surgery for sleep apnea. [2] Lee et al (2022)found that Black men had a continuous mortality increase specifically related to OSA over the study period(1999 to 2019; annual percentage change 2.7%; 95% confidence interval, 1.2 to 4.2) compared to any other racial group. [3]

Regulatory Status

The regulatory status of minimally invasive surgical interventions is shown in Table 1.

Table 1. Minimally Invasive Surgical Interventions for Obstructive Sleep Apnea

Interventions	Devices (predicate or prior name)	Manufacturer (previously owned by)	Indication	PMA/ 501(k)	Year	FDA Product Code
LAUP	Various					
Radiofrequency ablation	Somnoplasty®		Simple snoring and for the base of the tongue for OSA	K982717	1998	GEI
Palatal implant	Pillar® Palatal Implant	Pillar Palatal (Restore Medical/ Medtronic)	Stiffening the soft palate which may reduce the severity of snoring and incidence of airway obstructions in patients with mild to moderate OSA	K040417	2004	LRK
Tongue base suspension	AIRvance® (Repose)	Medtronic	OSA and/or snoring. The AIRvance TM Bone Screw System is also suitable for the performance of a hyoid suspension	K122391	1999	LRK
Tongue base suspension	Encore™ (PRELUDE III)	Siesta Medical	Treatment of mild or moderate OSA and/or snoring	K111179	2011	ORY
Hypoglossal nerve stimulation (HNS)	Inspire II Upper Airway Stimulation	Inspire Medical Systems	Patients ≥ 18 years with AHI ≥15 and ≤65 who have failed (AHI >15 despite CPAP usage) or cannot tolerate (<4 h use per night for ≥5 nights per week) CPAP and do not have complete concentric collapse at the soft palate level. Patients between ages 18 and 21 should also be contraindicated for or not effectively treated by adenotonsillectomy.	P130008 S039	2014	MNQ
HNS	aura6000®	ImThera Medical		IDE	2014	
HNS	Genio ™	Nyxoa		European CE Mark	2019	
HNS	Apnex System®	Apnex				

AHI: Apnea/Hypopnea Index; CPAP: continuous positive airway pressure; IDE: investigational device exemption; LAUP: Laser-assisted uvulopalatoplasty; OSA: obstructive sleep apnea.

Medical Policy Statement

Certain surgical procedures have been established as safe and effective for the treatment of clinically significant obstructive sleep apnea (OSA) when conservative therapies or CPAP have failed. The procedure selected should be based on the patient's anatomy and the OSA etiology.

Hypoglossal nerve stimulation, using an FDA-approved device is considered established when criteria are met.

Hypoglossal nerve stimulation for those not meeting the inclusion criteria is considered experimental/investigational.

Hypoglossal nerve stimulators that are not FDA-approved are considered experimental/investigational.

Drug-induced sleep endoscopy (DISE) replicates sleep with an infusion of propofol. DISE will suggest either a flat, anterior-posterior collapse or complete circumferential oropharyngeal collapse. Concentric collapse decreases the success of hypoglossal nerve stimulation and is an exclusion criterion from the U.S. Food and Drug Administration.

The use of the DISE procedure is considered established to evaluate appropriateness of FDA-approved hypoglossal nerve stimulation when all of the criteria for hypoglossal nerve stimulation are met.

The DISE procedure is considered experimental/investigational for all other indications.

Inclusionary and Exclusionary Guidelines

Inclusions:

- Palatopharyngoplasty (eg, uvulopalatopharyngoplasty, uvulopharyngoplasty, uvulopalatal flap, expansion sphincter pharyngoplasty, lateral pharyngoplasty, palatal advancement pharyngoplasty, relocation pharyngoplasty) for the treatment of clinically significant** obstructive sleep apnea syndrome (OSA) in adult patients who have not responded to or do not tolerate continuous positive airway pressure (CPAP) or failed an adequate trial of an oral appliance

- Hyoid suspension, surgical modification of the tongue, and/or maxillofacial surgery, including mandibular-maxillary advancement (MMA) in adult patients with clinically significant** OSA and objective documentation of hypopharyngeal obstruction who have not responded to or do not tolerate CPAP or failed an adequate trial of an oral appliance

- Adenotonsillectomy in pediatric patients with OSA and hypertrophic tonsils, and:
  - AHI or RDI of at least 5 per hour, or
  - AHI or RDI of at least 1.5 per hour in a patient with excessive daytime sleepiness, behavioral problems, or hyperactivity

***Clinically significant OSA is defined as patients who have:*
- *AHI or RDI of 15 or more events per hour, or*
- *AHI or RDI of at least 5 events per hour with 1 or more signs or symptoms associated with OSA (eg, excessive daytime sleepiness, hypertension, cardiovascular heart disease, or stroke).*

- Hypoglossal nerve stimulation:
  - Member is 22 years of age or older; AND

- AHI is ≥15 events per hour; AND
- Total number of central and mixed apneas are less than 25% of the total AHI; AND
- Member has a minimum of 30 days of CPAP documentation monitoring that:
  - Demonstrates CPAP failure (AHI ≥15 despite usage of 4 or more hours per night, 5 nights per week), OR
  - Demonstrates CPAP intolerance (usage is less than 4 hours per night, 5 nights per week); AND
- Non-concentric retropalatal obstruction on drug-induced sleep endoscopy; AND
- Body mass index (BMI) is less than 32 kg/m^2; AND
- The sleep study used for the AHI is performed within 24 months of the first consultation for the hypoglossal nerve stimulator

Adolescent or young-adult member:
- Between the ages of 18 and 21; AND
- Moderate to severe OSA (15 ≤ AHI ≤ 65); AND
- Non-concentric retropalatal obstruction on drug-induced sleep endoscopy; AND
- A contraindication to, or not effectively treated by, adenotonsillectomy; AND
- Has been confirmed to fail, or cannot tolerate, PAP therapy despite attempts to improve compliance; AND **
- Has followed standard of care in considering all other alternative/adjunct therapies

** *PAP failure is defined as an inability to eliminate OSA (AHI of greater than 15 despite PAP usage), and PAP intolerance is defined as:*
  - *Inability to use PAP (greater than 5 nights per week of usage; usage defined as greater than 4 hours of use per night), or*
  - *Unwillingness to use PAP (for example, a patient returns the PAP system after attempting to use it).*

Adolescent or young-adult member with Down syndrome:
- Member is 10 to 21 years of age; AND
- Member had a prior adenotonsillectomy; AND
  - AHI is greater than 10 and less than 50; AND
  - Total number of central and mixed apneas are less than 25% of the total AHI following adenotonsillectomy; AND
- Member has either:
  - a tracheostomy, or
  - ineffective treatment with CPAP due to noncompliance, discomfort, undesirable side effects, persistent symptoms despite compliant use or refusal to use the device; AND
- Body mass index (BMI) at the 95th percentile or lower for age, AND
- Non-concentric retropalatal obstruction on drug-induced sleep endoscopy

- Drug-induced sedation endoscopy (DISE):
  - The DISE procedure is established to evaluate the appropriateness of FDA-approved hypoglossal nerve stimulation when all the criteria for hypoglossal nerve stimulation are met.

Exclusions:
- Laser-assisted palatoplasty (LAUP)

- Midline glossectomy (MLG)
- Palatal stiffening procedures (eg, cautery-assisted and injection snoreplasty)
- Palatal implants
- Radiofrequency volumetric tissue reduction (RVTR) of the tongue
- Radiofrequency reduction of the palatal tissues (i.e., Somnoplasty)
- Tongue base suspension (i.e., Repose system)
- All other minimally invasive surgical procedures not described above
- All interventions for the treatment of snoring in the absence of documented OSA; snoring alone is not considered a medical condition
- The DISE procedure is considered experimental/investigational for all other indications

Exclusions for hypoglossal nerve stimulation:

- Any anatomical finding that would compromise the performance of the device
- Any condition or procedure that has compromised neurological control of the upper airway
- Members who are unable or do not have the necessary assistance to operate the sleep remote
- Members who are pregnant or plan to become pregnant
- Members who are known to require magnetic resonance imaging (this does not apply to a model that is MR compatible)
- Members with an implantable device that may be susceptible to unintended interaction with the device

Hypoglossal nerve stimulation for those not meeting the inclusion criteria is considered experimental/investigational.

Hypoglossal nerve stimulators that are not FDA-approved are considered experimental/investigational.

CPT/HCPCS Level II Codes *(Note: The inclusion of a code in this list is not a guarantee of coverage. Please refer to the medical policy statement to determine the status of a given procedure.)*

Established codes:

21120	21121	21122	21123	21141	21193
21196	21198	21199	42140	42145	42975
64582	64583	64584			

Other codes (investigational, not medically necessary, etc.):

41512	41530	42299	S2080

Note: Code(s) all codes may not be covered by all contracts or certificates. Please consult customer or provider inquiry resources at BCBSM or BCN to verify coverage.

Individual policy criteria determine the coverage status of the CPT/HCPCS code(s) on this policy. Codes listed in this policy may have different coverage positions (such as established or experimental/investigational) in other medical policies.

Rationale

This review was informed by BCBSA TEC Assessments on the surgical management and radiofrequency volumetric tissue reduction for obstructive sleep apnea (OSA).[4,5]

Evidence reviews assess the clinical evidence to determine whether the use of a technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life, and ability to function-including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of a technology, 2 domains are examined: the relevance and the quality and credibility. To be relevant, studies must represent one or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is associated with a heterogeneous group of anatomic variants producing obstruction. The normal pharyngeal narrowing may be accentuated by anatomic factors, such as a short, fat “bull” neck, elongated palate and uvula, and large tonsillar pillars with redundant lateral pharyngeal wall mucosa. In addition, OSA is associated with obesity. OSA may also be associated with craniofacial abnormalities, including micrognathia, retrognathia, or maxillary hypoplasia. Obstruction anywhere along the upper airway can result in apnea. The severity and type of obstruction may be described with the Friedman staging system.[6] Nonsurgical treatment for OSA or UARS includes positive airway pressure (CPAP) or mandibular repositioning devices, which are addressed in the BCBSM medical policy “Sleep Disorders, Diagnosis and Medical Management”. Patients who fail conservative therapy may be evaluated for surgical treatment of OSA.

Traditional surgeries for OSA or upper airway resistance syndrome include uvulopalatopharyngoplasty (UPPP) and a variety of maxillofacial surgeries such as mandibular-maxillary advancement. UPPP involves surgical resection of the mucosa and submucosa of the soft palate, tonsillar fossa, and the lateral aspect of the uvula. The amount of tissue removed is individualized for each patient, as determined by the potential space and width of the tonsillar pillar mucosa between the 2 palatal arches. UPPP enlarges the oropharynx but cannot correct obstructions in the hypopharynx. Patients who have minimal hypoglossal obstruction have greater success with UPPP. Patients who fail UPPP may be

candidates for additional procedures, depending on the site of obstruction. Additional procedures include hyoid suspensions, maxillary and mandibular osteotomies, or modification of the tongue. Drug-induced sleep endoscopy and/or cephalometric measurements have been used as methods to identify hypopharyngeal obstruction in these patients. The first-line treatment in children is usually adenotonsillectomy. Minimally invasive surgical approaches are being evaluated for OSA in adults.

Clinical Context and Therapy Purpose

The purpose of minimally invasive surgery in patients who have OSA is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: Do the surgical interventions addressed in this evidence review improve the net health outcome in patients with OSA?

The following PICO was used to select literature to inform this review.

Populations

The population of interest includes patients with OSA who have failed or are intolerant of positive airway pressure. Terminology and diagnostic criteria for OSA are shown in Table 2. Indications for the various procedures are described in Table 3 and in the Regulatory Status section.

Table 2. Terminology and Diagnostic Criteria for Obstructive Sleep Apnea

Terms	Definition
Apnea	The frequency of apneas and hypopneas is measured from channels assessing oxygen desaturation, respiratory airflow, and respiratory effort. In adults, apnea is defined as a drop in airflow by >=90% of pre-event baseline for at least 10 seconds. Due to faster respiratory rates in children, pediatric scoring criteria define an apnea as >=2 missed breaths, regardless of its duration in seconds.
Hypopnea	Hypopnea in adults is scored when the peak airflow drops by at least 30% of pre-event baseline for at least 10 seconds in association with either at least 3% or 4% decrease in arterial oxygen desaturation (depending on the scoring criteria) or an arousal. Hypopneas in children are scored by a >=50% drop in nasal pressure and either a >=3% decrease in oxygen saturation or an associated arousal.
Apnea/Hypopnea Index (AHI)	The average number of apneas or hypopneas per hour of sleep
Obstructive sleep apnea (OSA)	Repetitive episodes of upper airway obstruction due to the collapse and obstruction of the upper airway during sleep
Mild OSA	In adults: AHI of 5 to <15 In children: AHI ≥1.5 is abnormal
Moderate OSA	AHI of 15 to < 30
Severe OSA	Adults: AHI ≥30 Children: AHI of ≥15
Positive airway pressure (PAP)	Positive airway pressure may be continuous (CPAP) or auto-adjusting (APAP) or Bi-level (Bi-PAP).
PAP Failure	Usually defined as an AHI greater than 20 events per hour while using PAP
PAP Intolerance	PAP use for less than 4 h per night for 5 nights or more per week, or refusal to use CPAP. CPAP intolerance may be observed in patients with mild, moderate, or severe OSA

Interventions

The interventions addressed in this review are laser-assisted uvulopalatoplasty (LAUP), radiofrequency volumetric reduction of palatal tissues and base of tongue, palatal stiffening procedures, tongue base suspension, and hypoglossal nerve stimulation (HNS) (see Table 3).

Table 3. Minimally Invasive Surgical Interventions for OSA

Interventions	Devices	Description	Key Features	Indications
LAUP	Various	Superficial palatal tissues are sequentially reshaped over 3 to 7 sessions using a carbon dioxide laser	• Part of the uvula and associated soft-palate tissues are reshaped • Does not alter tonsils or lateral pharyngeal wall tissues • Tissue ablation can be titrated	Snoring with or without OSA
RF volumetric reduction of palatal tissues and base of tongue	Somnoplasty	Radiofrequency is used to produce thermal lesions within the tissues	• Similar to LAUP Can include soft palate and base of tongue	Simple snoring and base of tongue OSA
Palatal Implant	Pillar Palatal Implant	Braided polyester filaments that are implanted submucosally in the soft palate	Up to 5 implants may be used	Snoring
Tongue base suspension	AIRvance Encore	A suture is passed through the tongue and fixated with a screw to the inner side of the mandible, below the tooth roots	The aim of the suspension is to make it less likely for the base of the tongue to prolapse during sleep	Snoring and/or OSA
Hypoglossal nerve stimulation (HNS)	Inspire II Upper Airway Stimulation	Stimulation of the hypoglossal nerve which contracts the tongue and some palatal tissue	The device includes an implanted stimulator and a sensor implanted in the ribs to detect respiration.	A subset of patients with moderate-to-severe OSA who have failed or cannot tolerate CPAP (see Regulatory Status section)

CPAP: positive airway pressure; LAUP: laser-assisted uvulopalatoplasty; OSA: obstructive sleep apnea; RF: radiofrequency.

Comparators

The following therapies and practices are currently being used to treat OSA:

For patients with mild OSA who are intolerant of CPAP, the comparator would be oral appliances or an established upper airway surgical procedure.

For patients with moderate to severe OSA who have failed CPAP or are intolerant of CPAP, the comparator would be conventional surgical procedures such as maxillofacial surgeries that may include UPPP, hyoid suspensions, maxillary and mandibular osteotomies, and modification of the tongue. UPPP may be modified or combined with a tongue-base procedure such as uvulopalatopharyngoglossoplasty (UPPGP), depending on the location of obstruction. It is uncertain whether UPPP variants without tongue volume reduction are the most appropriate comparator for HNS, since the procedures may address different sources of obstruction.

Outcomes

Established surgical procedures are associated with adverse effects such as dysphagia. In addition, the surgical procedures are irreversible should an adverse effect occur. Therefore, an improvement in effectiveness and/or a decrease in adverse events compared to standard surgical procedures would be the most important outcomes.

The outcomes of interest are a decrease in Apnea/Hypopnea Index (AHI) and Oxygen Desaturation Index on polysomnography (PSG) and improvement in a measure of sleepiness such as the Epworth Sleepiness Scale (ESS) or Functional Outcomes of Sleep (FOSQ) (see Table 4).

Table 4. Health Outcome Measures Relevant to OSA

Outcome	Measure (Units)	Description	Clinically Meaningful Difference (If Known)
Change in AHI	AHI	Mean change in AHI from baseline to post-treatment	Change from severe to moderate or mild OSA
AHI Success	Percentage of patients achieving success.	Studies may use different definitions of success; the most common definition of AHI success is the Sher criteria	Sher criteria is a decrease in AHI ≥50% and an AHI <20 Alternative measures of success may be AHI <15, <10, or <5
Oxygen Desaturation Index	Oxygen levels in blood during sleep	The number of times per hour of sleep that the blood oxygen level drops by ≥4 percentage points	More than 5 events per hour
Snoring	10-point visual analog score	Filled out by the bed partner to assess snoring intensity or frequency	There is no standard for a good outcome. Studies have used 50% decrease in VAS[5.] or final VAS of <5 or <3[6.]
Epworth Sleepiness Score (ESS)	Scale from 0 to 24	The ESS is a short, self-administered questionnaire that asks patients how likely they are to fall asleep in 8 different situations such as watching TV, sitting quietly in a car, or sitting and talking to someone	An ESS of ≥10 is considered excessively sleepy. The MCID has been estimated at -2 to -3.[4,]
Functional Outcomes of Sleep Questionnaire	30 questions	Disease-specific quality of life questionnaire that evaluates functional status related to excessive sleepiness	A score of ≥18 is the threshold for normal sleep-related functioning, and a change of ≥2 points is considered to be a clinically meaningful improvement
OSA-18	18 item surveys graded from 1 to 7	Validated survey to assess quality of life in child	Change score of 0.5 to 0.9 is a small change, 1.0 to 1.4 a moderate change, and 1.5 a large change

AHI: Apnea/Hypopnea Index; VAS: visual analog score.

The effect of surgical treatment of OSA should be observed on follow-up PSG that would be performed from weeks to months after the surgery. Longer-term follow-up over 2 years is also needed to determine whether the effects of the procedure are durable or change over time.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Laser-Assisted Uvulopalatoplasty

LAUP is proposed as a treatment of snoring with or without associated OSA. LAUP cannot be considered an equivalent procedure to the standard UPPP, with the laser simply representing a surgical tool that the physician may opt to use. LAUP is considered a unique procedure, which raises its own issues of safety and, in particular, effectiveness.

One RTC (Ferguson et al [2003]) on LAUP has been identified.[9] This study compared LAUP with no treatment, finding treatment success (AHI <10) to be similar between LAUP (24%) and no treatment controls (17%) (see Tables 5 and 6). The primary benefit of LAUP was on snoring as rated by the bed partner. Subjective improvements in ESS and quality of life were not greater in the LAUP group in this non-blinded study (see Tables 7 and 8). Adverse effects of the treatment included moderate-to-severe pain and bleeding in the first week and difficulty swallowing at follow-up.

Table 5. Summary of Key Randomized Controlled Trial Characteristics

Study	Countries	Sites	Participants	Interventions[1]	
				Active	Comparator
Ferguson et al (2003)	Canada	1	46 patients with mild-to-moderate symptomatic OSA (AHI of 10 to 25) and loud snoring	21 patients treated with LAUP every 1-2 mo[1]	25 patients received no treatment

AHI: Apnea/Hypopnea Index; LAUP: laser-assisted uvulopalatoplasty.

[1] The LAUP procedure was repeated at 1- to 2-month intervals until either the snoring was significantly reduced, no more tissue could safely be removed, or the patient refused further procedures. There was a mean of 2.4 procedures (range, 1-4).

Table 6. Summary of Key Randomized Controlled Trial Results

Study	Treatment Success (AHI <10)	Change in Snoring (10- point VAS)	Change in ESS	Change in SAQLI Quality of Life	Moderate-to-Severe Pain in First Week	Bleeding in First Week	Difficulty Swallowing at Follow-up
Ferguson et al (2003)							
N	45	45	45	45	45	45	45
LAUP	24%	-4.4	-1.4	+0.4	81%	19%	19%
No treatment	17%	-0.4	+0.8	+0.2			
p	NR	<0.001	NS	NS			

AHI: Apnea/Hypopnea Index; ESS: Epworth Sleepiness Scale (maximum of 24); LAUP: laser-assisted uvulopalatoplasty; NS: not significant; NR: not reported; SAQLI: Sleep Apnea Quality of Life Index (maximum of 7); VAS: visual analog scale.

Study limitations are described in Tables 7 and 8. The major flaw is the uncertain clinical significance of the outcome measure.

Table 7. Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Ferguson et al (2003)	1. Entry criteria includes populations with mild OSA (AHI between 10 and 15) for whom an improvement to AHI <10 is not clinically significant		3. Controls had no treatment	6. The definition of success (AHI <10) combined with the eligibility criteria (AHI >10) can lead to clinically insignificant improvements being labeled success	

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. AHI: Apnea/Hypopnea Index; OSA: obstructive sleep apnea.
a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 8. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Ferguson et al (2003)		1.-3. No blinding				4. Comparison of primary outcome not reported

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Section Summary: Laser-Assisted Uvulopalatoplasty

A single RCT has been identified on LAUP for the treatment of mild-to-moderate OSA. LAUP improved snoring as reported by the bed partner but did not improve treatment success in terms of AHI when compared to no treatment controls. Patients in this non-blinded study did not report an improvement in ESS or QOL after LAUP.

Radiofrequency Volumetric Reduction of Palatal Tissues and Base of Tongue

RF is used to produce thermal lesions within the tissues rather than using a laser to ablate the tissue surface. In some situations, RF of the soft palate and base of tongue are performed together as a multilevel procedure.

The analysis of RF volumetric tissue reduction was informed by a TEC Assessment (2000) that evaluated 4 primary studies on palatal radiofrequency ablation (RFA) and 1 study on tongue base RFA.[4] All studies were nonrandomized.

Randomized Controlled Trials

Two RCTs have subsequently been identified on RF volumetric reduction of the palate and tongue. One of the trials (Back et al [2009]) gave a single RF treatment to palatal tissues and found no statistical difference in scores on the AHI, VAS for snoring, ESS, or FOSQ between RF and sham (see Tables 9-11).[10] The second trial (Woodson et al [2003]), provided a mean of 4.8 sessions of RF to the tongue and palate. This trial found a statistically significant improvement from baseline to post-treatment for ESS and FOSQ.[11] However, the improvement in FOSQ score (1.2; standard deviation,1.6) was below the threshold of 2.0 for clinical significance and the final mean score in ESS was 9.8, just below the threshold for excessive sleepiness. AHI decreased by 4.5 events per hour, which was not statistically or clinically significant. The statistical significance of between-group differences was not reported (see Table 12).

Table 9. Summary of Key Randomized Controlled Trial Characteristics

Study	Countries	Sites	Participants	Interventions	
				Active	Comparator
Back et al (2009)	Finland	1	32 patients with symptomatic mild OSA and habitual snoring with only velopharyngeal obstruction	Single-stage RF to palatal tissues	Sham control with local anesthetic and multiple insertions of an applicator needle without the RF
Woodson et al (2003)	U.S.	2	90 patients with symptomatic mild-to-moderate OSA, randomized to RF, sham, or CPAP	30 subjects received up to 7 sessions (mean, 4.8) of RF to tongue base and palate	30 subjects received sham procedure to tongue for 3 sessions, including local anesthetic and multiple insertions of an applicator needle without the RF

CPAP: continuous positive airway pressure; OSA: obstructive sleep apnea; RF: radiofrequency.

Table 10. Summary of Key Randomized Controlled Trial Results

Study	AHI	Snoring	ESS	Function	Adverse Events
	Median (Range)	Snoring Median (Range)	Median (Range)	Compound End Point Score[a] Median (Range)	
Back et al (2009)					
N	32	30	32	32	32
RF	13.0 (2.0-26.0)	5.0 (2.0-8.0)	7.0 (0-20.0)	6 (3-9)	
Sham	11.0 (1.0-29.0)	6.0 (3.0-8.0)	5.0 (2.0-15.0)	7 (4-10)	
p	0.628	0.064	0.941	0.746	No significant differences after 6 d
	Change Score (SD)		Change Score (SD)	FOSQ Score (SD)	
Woodson et al (2003)					
N	52		54	54	54

RF	-4.5 (13.8)		-2.1 (3.9)b	1.2 (1.6)b	
Sham	-1.8 (11.5)		-1.0 (3.1)	0.4 (2.0)	
Effect size	0.34		0.50	0.66	No significant differences after 1 wk

AHI: Apnea/Hypopnea Index; ESS: Epworth Sleepiness Scale (maximum of 24); FOSQ: Functional Outcomes of Sleep Questionnaire; MCS: Mental Component Summary score; PCS: Physical Component Summary score; SD: standard deviation; SF-36: 36-Item Short-Form Health Survey.
a The compound end point scored added points derived from AHI, ESS, SF-36 PCS, and SF-36 MCS;
b p=0.005 for baseline to posttreatment.

Tables 11 and 12 display notable limitations identified in each study.

Table 11. Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Back et al (2009)	4. Included patients with mild OSA and snoring	4. Single treatment with RFA			
Woodson et al (2003)					

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. OSA: obstructive sleep apnea; RFA: radiofrequency ablation.
a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 12. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Back et al (2009)		2. Surgeons also performed follow-up assessments				.
Woodson et al (2003)						3. Comparative treatment effects not reported

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Section Summary: Radiofrequency Volumetric Reduction of Palatal Tissues and Base of Tongue

The evidence on radiofrequency volume reduction includes 2 randomized trials, both sham controlled. Single-stage RF to palatal tissues did not improve outcomes compared to sham. Multiple sessions of RF to the palate and base of tongue did not significantly (statistically or

clinically) improve AHI, while the improvement in functional outcomes did not achieve a level of clinical significance.

Palatal Stiffening Procedures

Palatal stiffening procedures include insertion of palatal implants, injection of a sclerosing agent (snoreplasty), or a cautery-assisted palatal stiffening operation. Snoreplasty and cautery-assisted palatal stiffening operations are intended for snoring and are not discussed here. Palatal implants are cylindrically shaped devices that are implanted in the soft palate.

Randomized Controlled Trials

Two double-blind sham-controlled randomized trials with over 50 patients have evaluated the efficacy of palatal implants to improve snoring and OSA (see Table 13). AHI success by the Sher criteria ranged from 26% to 45% at 3-month follow-up. AHI success was observed in 0% to 10% of the sham control patients (see Table 14). In 1 study (Steward et al [2008]), the statistical significance of AHI success was marginal and there was no statistical difference in snoring or change in ESS between the 2 groups.[12] In the study by Friedman et al (2008), there was greater success in AHI (45% vs 0%, p<0.001), improvement in snoring (-4.7 vs -0.7 on a 10-point VAS, p<0.001), and improvement in ESS (-2.4 vs -0.5, p<0.001) with palatal implants compared with sham controls.[3] Patient selection criteria were different in the 2 studies. In Friedman et al (2008), patients with a Friedman tongue position of IV and palate of 3.5 cm or longer were excluded, whereas in the trial by Steward et al (2008), selection criteria included patients with *primarily* retropalatal pharyngeal obstruction.

Table 13. Summary of Key Randomized Controlled Trial Characteristics

Study	Countries	Sites	Participants	Interventions	
				Active	Comparator
Steward et al (2008)	U.S.	3	100 patients with mild-to-moderate OSA (AHI >=5 and <=40), and primarily retropalatal pharyngeal obstruction, BMI <=32 kg/m2	50 received the office-based insertion of 3 palatal implants	50 received the sham procedure
Friedman et al (2008)	U.S.	1	62 patients with mild-to-moderate OSA (AHI >=5 and <=40), soft palate >=2 cm and <3.5 cm, Friedman tongue position I, II, or III, BMI <=32 kg/m2	31 received the office-based insertion of 3 palatal implants	31 received the sham procedure

AHI: Apnea/Hypopnea Index, BMI: body mass index; OSA: obstructive sleep apnea.

Table 14. Summary of Key Randomized Controlled Trial Results

Study	AHI Success (Sher criteria)	Snoring (10-point VAS)	Change in ESS (95% CI) or (SD)	Change in FOSQ Score (95% CI)	Foreign Body Sensation/ Extrusion
Steward et al (2008)					
N	97	43	96	98	100
Palatal implants	26%	6.7	-1.8 (-0.8 to -2.9)	1.43 (0.84 to 2.03)	18%/4 extruded
Sham control	10%	7.0	-1.5 (-.04 to -2.5)	0.6 (0.01 to 1.20)	2%
p	0.04	0.052	NS	0.05	
Friedman et al (2008)		Change in VAS			
N	55	62	62		

Palatal implants (SD)	44.8%	-4.7 (2.1)	-2.4 (2.2)		2 extruded
Sham control (SD)	0%	-0.7 (0.9)	-0.5 (1.5)		
MD (95% CI)		4.0 (3.2 to 4.9)	1.9 (1.0 to 2.9)		
p	<0.001	< 0.001	<0.001		
Summary: Range	26%-44.8%				

CI: confidence interval; ESS: Epworth Sleepiness Score; MD: mean difference; NS: not significant; RCT: randomized controlled trial; RR: relative risk; SD: standard deviation; VAS: visual analog scale.

Case Series

Uncontrolled series have provided longer follow-up data on patients treated with palatal implants. Using criteria of 50% improvement in AHI and final AHI of less than 10 events hour, Neruntarat et al (2011) reported a success rate of 52% at a minimum of 24 months (see Tables 15 and 16).[13] Compared with non-responders, responders had lower body mass index, lower baseline AHI and a lower percentage of patients with a modified Mallampati classification of III or IV (obscured visualization of the soft palate by the tongue). Tables 17 and 18 summarize the limitations of the studies described above.

Table 15. Summary of Key Case Series Characteristics

Study	Country	Participants	Follow-Up
Neruntarat et al (2011)	Thailand	92 patients with mild-to-moderate symptomatic OSA and palate >2 cm	Minimum 24 mo

OSA: obstructive sleep apnea.

Table 16. Summary of Key Case Series Results

Study	N	AHI (SD)	Snoring (SD) (10-point VAS)	ESS (SD)	Implant Extrusion
Neruntarat et al (2011)	92				
Baseline		21.7 (6.8)	8.2 (1.2)	12.3 (2.6)	
29 months		10.8 (4.8)	3.8 (2.3)	7.9 (1.8)	7 (7.6%)
p		<0.001	<0.001	<0.001	

AHI: Apnea/Hypopnea Index; ESS: Epworth Sleepiness Score; SD: standard deviation; VAS: visual analog scale.

Table 17. Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Neruntarat et al (2011)			2. No comparator		
Steward et al (2008)					1, 2. 3 mo
Friedman et al (2008)					1, 2. 3 mo

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 18. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Neruntarat et al (2011)	Retrospective	None (case series)				
Steward et al (2008)						
Friedman et al (2008)						

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Section Summary: Palatal Stiffening Procedures

Two sham-controlled trials and several case series have assessed palatal implants for the treatment of snoring and OSA. The sham-controlled studies differed in the inclusion criteria, with the study that excluded patients with Friedman tongue position of IV and palate of 3.5 cm or longer reporting greater improvement in AHI (45% success) and snoring (change of -4.7 on a 10-point VAS) than the second trial.

Tongue Base Suspension

In this procedure, the base of the tongue is suspended with a suture that is passed through the tongue and fixated with a screw to the inner side of the mandible, below the tooth roots. The aim of the suspension is to make it less likely for the base of the tongue to prolapse during sleep.

Review of Evidence

One preliminary RCT with 17 patients was identified that compared UPPP plus tongue suspension to UPPP plus tongue advancement (see Table 19).[14] Success rates using the Sher criteria ranged from 50% to 57% (see Table 20). Both treatments improved snoring and reduced ESS to below 10. The major limitations of the study were the number of subjects (n=17) in this feasibility study and the lack of blinding (see Tables 21 and 22). In addition, there was no follow-up after 16 weeks.

Table 19. Summary of Key Randomized Controlled Trial Characteristics

Study	Countries	Sites	Participants	Interventions	
				Active	Comparator
Thomas et al (2003)	U.S.	1	17 patients with moderate-to-severe OSA who failed conservative treatment	UPPP with tongue suspension Mean AHI=46 (n=9)	UPPP with tongue advancement Mean AHI=37.4 (n=8)

AHI: Apnea/Hypopnea Index; OSA: obstructive sleep apnea; UPPP: uvulopalatopharyngoplasty.

Table 20. Summary of Key Randomized Controlled Trial Results

Study	AHI Success (Sher Criteria)	Snoring (SD)	ESS (SD)	Pain, Speech, Swallowing
Thomas et al (2003)				

N	11	17	17	17
UPPP plus tongue suspension	57%	3.3 (2.1)a	4.1 (3.4)b	
UPPP plus tongue advancement	50%	5.0 (0.6)c	5.4 (3.5)d	No significant differences between groups

AHI: Apnea/Hypopnea Index; ESS: Epworth Sleepiness Score; SD: standard deviation; UPPP: uvulopalatopharyngoplasty.
[a] Baseline to posttreatment p=0.02.
[b] Baseline to posttreatment p=0.007.
[c] Baseline to posttreatment p=0.04.
[d] Baseline to posttreatment p=0.004.

Table 21. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Thomas et al (2003)					1, 2. Follow-up was to 16 wk

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 22. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Thomas et al (2003)	3. Allocation concealment unclear	1.-3. Not blinded			1. Feasibility study	4. Comparative treatment effects not calculated

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Section Summary: Tongue Base Suspension

One feasibility study with 17 patients was identified on tongue suspension. This study compared tongue suspension plus UPPP to tongue advancement plus UPPP and reported 50% to 57% success rates for the two procedures. RCTs with a larger number of subjects are needed to determine whether tongue suspension alone or added to UPPP improves the net health outcome.

Hypoglossal Nerve Stimulation

Stimulation of the hypoglossal nerve causes tongue protrusion and stiffening of the anterior pharyngeal wall, potentially decreasing apneic events. For patients with moderate-to-severe sleep apnea who have failed or are intolerant of CPAP, the alternative would be an established surgical procedure, as described above.

Systematic Reviews

A summary of systematic reviews is included in Tables 23 and 24.

Costantino et al conducted a systematic review and meta-analysis of 6- to 60-month outcomes following HNS[16] They identified 12 studies with a total of 350 patients with OSA who were treated with the Inspire, ImThera, or Apnex HNS systems. Only the Inspire device has obtained FDA approval as of April 2021 and contributed the largest number of patients to the meta-analysis. In addition to the trials described below by Steffen et al (2015, 2018)[17,18] and Strollo et al (STAR Trial, 2014, 2018,[19,20] several other trials with the Inspire system were included in the meta-analysis. At 6 mo follow-up, the overall change in AHI was -17.74 with an improvement in ESS of -5.36. At 12 mo follow-up, the change in AHI was -17.50 with an improvement in ESS of -5.27. Sixty-month data were provided only by the STAR trial as reported by Woodson et al (2018) and are described below.[21]

Table 23. Meta-analysis Characteristics

Study	Dates	Trials	Participants	N (Range)	Design	Duration
Constantino et al (2020)	Through 2018	12	Adult patients with moderate to severe OSA	350 (8-124)	Cohort	6, 12, and 60 mo

OSA: obstructive sleep apnea

Table 24. Meta-analysis Results

Study	AHI Change at 6 mo (95% CI)	AHI Change at 12 mo (95% CI)	ESS Change at 6 mo (95% CI)	ESS Change at 12 mo (95% CI)	AHI Success n(%) Sher Criteria[a]
Constantino et al (2020)					
Total N	210	255	210	255	
Inspire	-17.74 (-24.73 to -10.74)	-17.50 (-20.01 to -14.98)	-5.36 (-6.64 to -4.08)	-5.27 (-6.18 to -4.35)	115 (70%)
ImThera	-9.50 (-19.14 to 0.14)	-24.20 (-37.39 to -11.01)	-3.70 (-5.65 to -1.75)	-2.90 (-6.97 to 1.17)	46 (35%)
Apnex	-24.20 (-30.94 to -17.45)	-20.10 (-29.62 to -10.58)	-3.87 (-5.53 to -2.21	-4.20 (-6.30 to -2.10)	115 (59.8%)
I^2 (p)	*68%* (.004)	*0%* (.77)	*25%* (.25)	*27%* (.24)	
Range of N	8 to 56	13 to 124	21 to 56	13 to 124	

AHI: Apnea/Hypopnea Index; CI: confidence interval; ESS: Epworth Sleepiness Score.
[a]Surgical success according to Sher criteria is defined as a 50% reduction in AHI and overall AHI < 20.

Randomized Controlled Trials

Only 1 RCT has been identified on the effect of HNS in patients with OSA. Heiser et al (2021) conducted The Effect of Upper Airway Stimulation in Patients With Obstructive Sleep Apnea (EFFECT) trial, a multicenter, randomized, double-blind, crossover design study in adult patients with moderate-to-severe OSA (defined as AHI ≥ 15) who were intolerant to CPAP. [22] All individuals included in the study were White. All patients received implantation of HNS device (Inspire Medical Solutions) at least 6 months prior to enrollment. Baseline AHI before implantation was 32.2 events/h; after implantation, baseline AHI was approximately 8.3

events/h. All participants received therapeutic stimulation during the baseline visit. Patients were then randomized to 1 of 2 treatment groups: HNS-Sham (n=45) or Sham-HNS (n=44). After randomization, the HNS-Sham group received therapeutic stimulation and the Sham-HNS received sham stimulation for 1week. During the second week, the HNS-Sham group received sham stimulation while the Sham-HNS group received therapeutic stimulation. Changes in AHI over time showed a statistically significant decrease in AHI with stimulation compared to sham stimulation during the baseline, week 1, and week 2 visits. This meant that during week 1 when the HNS-Sham group received stimulation, they had significantly lower AHI; during week 2, when the Sham-HNS group received stimulation, they had significantly lower AHI. Similarly, participants reported a lower ESS with stimulation compared to sham stimulation during all visits. The change of AHI and ESS from baseline to the 1-week and 2-week visits was analyzed between the groups and investigators found no evidence of a carryover effect for AHI or ESS. Study characteristics and a summary of results are described in Tables 25 and 26, respectively.

Table 25. Summary of Key RCT Characteristics

Study; Trial	Countries	Sites	Dates	Participants	Interventions	
					Active	Comparator
Heiser et al (2021); EFFECT	Germany	3	2018-2019	Adults with moderate-to-severe OSA (AHI ≥15), intolerant to CPAP; 100% of participants were White	HNS for week 1 followed by crossover to sham in week 2 (n=45)	Sham stimulation for week 1 followed by crossover to HNS in week 2 (n=44)

AHI: Apnea/Hypopnea Index; CPAP: continuous positive airway pressure; HNS: hypoglossal nerve stimulation; OSA: obstructive sleep apnea; RCT: randomized controlled trial.

Table 26. Summary of Key RCT Results

Study	AHI response after 1 week (AHI ≤15 events/h)	Change in ESS after 1 week	Overall change from baseline in FOSQ across treatment modalities
Heiser et al (2021); EFFECT	N=89	N=89	N=86
HNS	73.3%	0.4 ± 2.3	0.2 (-0.5 to 0.9)
Sham	29.5%	5.0 ± 4.6	-1.9 (-2.6 to -1.2)
Difference (95% CI)	43.8% (25.1 to 62.5)	4.6 (3.1 to 6.1)	2.1 (1.4 to 2.8)
p-value	<.001	.001	<.001

AHI: Apnea/Hypopnea Index; CI: confidence interval; ESS: Epworth Sleepiness Scale; FOSQ: Functional Outcomes of Sleep Questionnaire; HNS: hypoglossal nerve stimulation; HR: hazard ratio; NNT: number needed to treat; OR: odds ratio; RCT: randomized controlled trial; RR: relative risk.

Notable study limitations are described in Tables 27 and 28.

Table 27. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Duration of Follow-up[e]
Heiser et al (2021); EFFECT	4. Study population was predominantly male and exclusively White				1., 2. Limited follow-up period precluded long-term evaluation of safety and efficacy

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. a Population key: 1. Intended use population unclear; 2. Study population is unclear; 3. Study population not representative of intended use; 4, Enrolled populations do not reflect relevant diversity; 5. Other. b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest(e.g., proposed as an adjunct but not tested as such); 5: Other. c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively; 5.Other.d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. Incomplete reporting of harms; 4.Not establish and validated measurements; 5. Clinically significant difference not prespecified; 6. Clinically significant difference not supported; 7.Other.e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms; 3. Other.

Table 28. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Heiser et al (2021); EFFECT		4. Most participants randomized to sham stimulation became aware of the group allocation, possibly impacting subjective outcomes				

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias; 5. Other. b Blinding key: 1. Participants or study staff not blinded; 2. Outcome assessors not blinded; 3. Outcome assessed by treating physician; 4. Other. c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication; 4. Other. d Data Completeness key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4.Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials); 7. Other. e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference;4. Other. f Statistical key: 1. Analysis is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Analysis is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated; 5. Other.

Comparative Studies

Study characteristics and results are described in Tables 29 and 30. Limitations in relevance and design and conduct, including comparative studies and 2 single-arm studies, are described in Tables 31 and 32.

Besides the RCT described above, comparative evidence consists of 3 studies that compared HNS to historical controls treated with UPPP or a variant of UPPP (expansion sphincter pharyngoplasty) and a study that compared HNS with transoral robotic surgery. AHI success by the Sher criteria ranged from 87% to 100% in the HNS group compared to 40% to 64% in the UPPP group. Posttreatment ESS was below 10 in both groups. It is not clear from these

studies whether the patients in the historical control group were similar to the subset of patients in the HNS group, particularly in regard to the pattern of palatal collapse and from patients who did not return for postoperative PSG.

Several comparative studies have addressed these concerns by only including patients who meet the criteria for HNS in the control group. Yu et al (2019) compared outcomes for patients who met the criteria for both HNS (non-concentric collapse on drug-induced sleep endoscopy) and transoral robotic surgery (retroglossal obstruction).[23] When patients with similar anatomic criteria were compared, HNS led to significantly better improvements in AHI, cure rate (defined as AHI < 5), and the percentage of time that oxygen saturation fell below 90%. Huntley et al (2021) selected patients in the control group who met criteria for HNS (non-concentric collapse on drug-induced sleep endoscopy and body mass index [BMI] criteria) but had been treated at their institutions by single or multi-level palatal and lingual surgery.20, There was no explanation of why the different treatments were given during the overlap period of 2010 to 2019, but the HNS patients were older and heavier. HNS resulted in a modestly greater decrease in AHI (HNS: -21.4 vs -15.9. p <.001), but not in ESS (HNS: -4.7 vs -5.8, p =.06). More patients in the HNS group achieved success by the Sher criteria (70% vs 48 to 49%) suggesting that there might be a clinical benefit for some patients.

Another report from Adherence and Outcome of Upper Airway Stimulation for OSA International Registry (ADHERE) registry investigators (Mehra et al, 2020) compared outcomes from HNS patients with patients who met criteria but had been denied insurance coverage.[25] In a post-hoc multivariate analysis, previous use of PAP and prior surgical procedures were predictors of insurance approval. In the group of patients who received HNS, the average use downloaded from the device was 5.6 h/night and 92% of patients had usage greater than 20 h/week. A majority of the comparator group (86%) were not using any therapy at follow-up. The remaining 14% were using PAP, an oral appliance, or underwent OSA surgery. The AHI decreased to 15 events/h (moderate OSA) on the night of the sleep test in patients with HNS, with only modest improvement in patients who did not receive HNS. The hours of use on the night of the post-operative sleep study were not reported, and the HNS patients may have been more likely to use their device on the test night. In addition, the use of a home sleep test for follow-up may underestimate the AHI. The ESS improved in the HNS group but worsened in the controls. This suggests the possibility of bias in this subjective measure in patients who were denied coverage.

Additional non-comparative reports from the ADHERE registry are described below.

Table 29. Summary of Observational Comparative Study Characteristics

Study	Study Type	Country	Dates	Participants	HNS	Traditional Surgery	Follow-Up
Shah et al (2018)	Retrospective series with historical controls	U.S.	HNS 2015-2016 UPPP 2003-2012	40 OSA patients with AHI >20 and <65, BMI <=32 kg mg/m2, failed CPAP, favorable pattern of palatal collapse[a]	35% had previously had surgery for OSA	UPPP 50% of patients had additional surgical procedures	2-13 mo
Huntley et al (2018)	Retrospective series with historical controls	U.S.	HNS 2014-2016	Retrospective review included treated patients who had a postoperative PSG	75 patients age 61.67 y with a favorable pattern of	33 patients age 43.48 y treated by ESP	To post-operative PSG

			Modified UPPP 2011-2016		palatal collapse		
Yu et al (2019)	Retrospective series with historical controls	U.S.	HNS 2014-2016 TORS 2011-NR	OSA patients with AHI >20 and <65, BMI ≤32 kg mg/m^2, failed CPAP, favorable pattern of palatal collapse[a]	27 patients age 62 with retroglossal collapse amenable to TORS	20 patients age 53 y who would have qualified for HNS and were treated by TORS	NR
Huntley et al (2020)	ADHERE registry compared to retrospective controls	US, EU	• HNS 2010- 2019 • Modified UPPP 2003-2019	OSA patients who were intolerant to CPAP and met HNS criteria of AHI 15 to 65, BMI < 35, and favorable pattern of palatal collapsea	465 registry patients treated with HNS who had 12 mo follow-up	233 patients who would have qualified for HNS and were treated by single level (68%) or multilevel (31%) surgery	173 days after surgery 383 days after HNS
Mehra et al (2020)	ADHERE registry	US, EU	2017-2019	OSA patients who were intolerant to CPAP and met HNS criteria of AHI 15 to 65, BMI < 35, and favorable pattern of palatal collapse[a]	250 registry patients treated with HNS	100 patients who qualified for HNS but were denied insurance coverage	6 to 24 months

BMI: body mass index; CPAP: continuous positive airway pressure; ESP: expansion sphincter pharyngoplasty; HNS: hypoglossal nerve stimulation; OSA: obstructive sleep apnea; PSG: polysomnography; UPPP: uvulopalatopharyngoplasty.
[a] A favorable pattern of palatal collapse is not concentric retropalatal obstruction on drug-induced sleep endoscopy.

Table 30. Summary of Key Observational Comparative Study Results

Study	Baseline AHI (SD)	Posttreatment AHI (SD)	AHI Success (%)Sher Criteria	Baseline ESS (SD)	Posttreatment ESS (SD)
Shah et al (2018)					
HNS	38.9 (12.5)	4.5 (4.8)b	20 (100%)	13 (4.7)	8 (5.0)b
UPPP	40.3 (12.4)	28.8 (25.4)a	8 (40%)	11 (4.9)	7 (3.4)b
Huntley et al (2018)					
HNS	36.8 (20.7)	7.3 (11.2)	86.7	11.2 (4.2)	5.4 (3.4)
ESP	26.7 (20.3)	13.5 (19.0)	63.6	10.7 (4.5)	7.0 (6.0)
p	0.003	0.003	0.008	0.565	NS
Yu et al (2018)		Average AHI Reduction	% Cure Rate	Change in SaO_2 <90%	
HNS		33.3	70.4%	14.1	
TORS		12.7	10.0%	1.3	
p-value		0.002	<0.001	0.02	
Huntley et al (2020)					
HNS	35.5 (15.0)	14.1 (14.4)	70	11.9 (5.5)	7.3 (4.7)

Single or multi-level UPPP	35.0 (13.1)	19.3 (16.3)	48 to 49	11.3 (5.1)	5.9 (4.0)
p-Value	.88	<.001	<.001	.22	.06
Mehra et al (2020)					
HNS	33.7 (13.4)	14.7 (13.8)		12.3 (5.5)	7.2 (4.8)
No HNS	34.9 (16.4)	26.8 (17.6)		10.9 (5.4)	12.8 (5.2)
p-Value	.95	<.001		.06	<.001

AHI: Apnea/Hypopnea Index; ESP: expansion sphincter pharyngoplasty; HNS: hypoglossal nerve stimulation; NS: not significant; Sher criteria: 50% decrease in AHI and final AHI <20; SD; standard deviation; UPPP: uvulopalatopharyngoplasty.
[a] Baseline vs posttreatment p<0.05.
[b] Baseline vs posttreatment p<0.001.

Table 31. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Shah et al (2018)			2. UPPP may not be preferred treatment for patients with primarily lingual obstruction		
Huntley et al (2018)	4. Study populations not comparable		1. Not clearly defined, few ESP patients had follow-up PSG		
Yu et al (2018)					1,2 Duration of follow-up unclear
Huntley et al (2020)	4. Study populations not comparable				1. The timing of follow-up was different (173 days after surgery and 383 days after HNS)
Mehra et al (2020)	4. Study populations not comparable		3. Hours of use on the test night was not reported. This may not represent the normal use of the device.		1. The timing of follow-up was different
Steffen et al (2018)			No comparator		
STAR trial			No comparator		

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. ESP: expansion sphincter pharyngoplasty; PSG: polysomnography; STAR: Stimulation Therapy for Apnea Reduction; UPPP: uvulopalatopharyngoplasty.
a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 32. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Data Completeness[d]	Power[e]	Statistical[f]
Shah et al (2018)	1. Not randomized (retrospective) 4. Inadequate control for selection bias	1.-3. No blinding				4. Comparative treatment effects not calculated

Huntley et al (2018)	1. Not randomized (retrospective)	1.-3. No blinding				
Yu et al (2018)	1. Not randomized (retrospective)					
Huntley et al (2020)	1. Not randomized (retrospective)	1.-3. No blinding				
Mehra et al (2020)	1. Not randomized	1.-3. No blinding			1. Power calculations not reported	
Steffen et al (2018)	1. Not randomized	1.-3. No blinding				
STAR trial	1. Not randomized	1.-3. No blinding				

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment. STAR: Stimulation Therapy for Apnea Reduction.
a Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
b Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
c Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
d Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

Single-Arm Studies

Characteristics and results of single-arm studies are described in Tables 33 to 35. Limitations are mentioned in Tables 31 and 32, above.

Results of prospective single-arm studies show success rates in 66% to 68% of patients who had moderate to severe sleep apnea and a favorable pattern of palatal collapse (see Tables 27 and 28). Mean AHI was 31 to 32 at baseline, decreasing to 14 to 15 at 12 months. ESS scores decreased to 6.5 to 7.0. All improvements were maintained through 5 years of follow-up. Discomfort due to the electrical stimulation and tongue abrasion were initially common but were decreased when stimulation levels were reduced (see Table 29). In the post-market study, a normal ESS score (< 10) was obtained in 73% of patients. A FOSQ score of at least 19 was observed in 59% of patients compared to 13% at baseline. At the 12-month follow-up, 8% of bed partners regularly left the room due to snoring, compared to 75% of bed partners at baseline. The average use was 5.6 + 2.1 h per night. Use was correlated with the subjective outcomes, but not with AHI response. Two- and 3-year follow-up of this study were reported by Steffen et al (2020),[18] but the percentage of patients at follow-up was only 68% at 2 years and 63% at 3 years, limiting conclusions about the longer-term efficacy of the procedure. A comparison of the populations who had 12-month versus 2- or 3-year results showed several differences between the patients who followed up and those who dropped out, including higher baseline AHI, higher baseline ODI, and trends towards lower usage per night and a lower responder rate at 12 months.

Table 33. Summary of Prospective Single-Arm Study Characteristics

Study	Country	Participants	Treatment Delivery	Follow-Up
STAR trial	EU, U.S.	126 patients with AHI >20 and <50, BMI <=32 kg/m2, failed CPAP, favorable pattern of palatal collapse[a]	Stimulation parameters titrated with full PSG	5 y
Postmarket studies: Heiser et al (2017) Steffen et al (2018) Hasselbacher et al (2018)	3 sites in Germany	60 patients with AHI >=15 and <=65 on home sleep study, BMI <=35 kg/m2, failed CPAP; favorable pattern of palatal collapse[a]		12 mo

AHI: apnea/hypopnea index; BMI: body mass index; CPAP: continuous positive airway pressure; STAR: Stimulation Therapy for Apnea Reduction.
a A favorable pattern of palatal collapse is non-concentric retropalatal obstruction on drug-induced sleep endoscopy.

Table 34. Summary of Prospective Single-Arm Study Results

Study	N	Percent of Patients With AHI Success (Sher criteria)	Mean AHI Score (SD)	Mean ODI Score (SD)	FOSQ Score (SD)	ESS Score (SD)
STAR trial						
Baseline	126		32.0 (11.8)	28.9 (12.0)	14.3 (3.2)	11.6 (5.0)
12 months	124	66%	15.3 (16.1)d	13.9 (15.7)d	17.3 (2.9)d	7.0 (4.2)d
3 years	116a	65%	14.2 (15.9)	9.1 (11.7)	17.4 (3.5)b	7.0 (5.0)b
5 years	97c	63%	12.4 (16.3)	9.9 (14.5)	18.0 (2.2)	6.9 (4.7)
Postmarket studies: Heiser et al (2017) Steffen et al (2018) Hasselbacher et al (2018)						
Baseline	60		31.2 (13.2)	27.6 (16.4)	13.7 (3.6)	12.8 (5.3)
6 months					17.5 (2.8)d	7.0 (4.5)d
12 months	56f	68%	13.8 (14.8)e	13.7 (14.9)e	17.5 (3)e	6.5 (4.5)e
Normalized at 12 months					59%	73%

AHI: Apnea/Hypopnea Index; ESS: Epworth Sleepiness Scale; FOSQ: Functional Outcomes of Sleep Questionnaire; ODI: Oxygen Desaturation Index; PSG: polysomnography; SD: standard deviation; STAR: Stimulation Therapy for Apnea Reduction.
Ninety-eight participants agreed to undergo PSG at 36 months of the 17 participants who did not undergo PSG at 36 months, 54% were non-responders and their PSG results at 12 or 18 months were carried forward. b The change from baseline was significant at p<0.001. c Seventy-one participants agreed to a PSG. f Four patients lost to follow-up were analyzed as treatment failures. d p<0.001.e p< 0.05.

Table 35. Device-Related Adverse Events From Prospective Single-Arm Studies

Study	N	Discomfort due to Electrical Stimulation[a]	Tongue Abrasion	Dry Mouth	Mechanical Pain From Device	Internal Device Usability	External Device Usability
STAR trial							
0 to 12 months	126	81	28	10	7	12	11
12 to 24 months	124	23	12	5	2	8	11
24 to 36 months	116	26	4	2	3	1	8

36 to 48 months	97	7	3	0	1	3	9
> 48 months		5	3	3	1	1	6
Participants with event, n of 126 (%)		76 (60.3)	34 (27.0)	19 (15.1)	14 (11.1)	21 (16.7)	33 (26.2)

STAR: Stimulation Therapy for Apnea Reduction.
a Stimulation levels were adjusted to reduce discomfort

Down Syndrome

Caloway et al (2020) reported a safety study of HNS in 20 children with Down Syndrome and severe OSA (AHI of 10 or greater) treated at 3 tertiary care centers.[35] Included were non-obese (BMI < 95%) children and adolescents aged 10-21 years who were refractory to tonsillectomy and either unable to tolerate CPAP or dependent on a tracheostomy. Patients were included whose AHI was between 10 and 50 on baseline PSG; the median baseline AHI was 24.15 (interquartile range [IQR] of 19.88 to 35.10). All of the patients tolerated the stimulation, and at 2 months after implantation the median AHI was 3.56 (IQR 2.61 to 4.40). Success, defined as an AHI of 5 or less (mild) with HNS, was achieve in 14 of 20 patients(70%). The median percent reduction in AHI was 85% with a median usage of 9.21 h (IQR: 8.29 to 9.50) per night. The OSA-18 score improved by 1.15 (IQR: 0.02 to 1.97), indicating a moderate but clinically significant change. There were 2 adverse events related to extrusion or connectivity of the stimulation or sensation leads, which were both corrected with wound exploration surgery. Study in a larger population of children with Down Syndrome is ongoing.

Yu et al (2022) reported on the safety and effectiveness of HNS in 42 adolescents with Down Syndrome and severe OSA (AHI of 10 events/h or greater).[36] This was a single-group, multicenter, cohort study with a 1-yearfollow-up that included non-obese (BMI <95%) children and adolescents aged 10 to 21 years who were refractory to adenotonsillectomy and unable to tolerate CPAP. Patients who were included had an AHI between10 and 50 on baseline PSG; the mean baseline AHI was 23.5 (SD, 9.7). All patients included tolerated HNS without any intraoperative complications. The most common complication was tongue or oral discomfort or pain, which occurred in 5 (11.9%) patients and was temporary, lasting weeks or rarely, months. Four patients(9.5%) had device extrusion resulting in readmissions to replace the extruded device. At 12 months, there was a mean decrease in AHI of 12.9 (SD, 13.2) events per hour (95% CI, -17.0 to -8.7 events/h). At the 12-monthPSG, 30 of 41 patients (73.2%) had an AHI of less than 10 events/h, 14/41 patients (34.1%) had an AHI of less than 5 events/h, and 3/41 patients (7.3%) had an AHI of less than 2 events/h. There was also a significant improvement in quality of life outcomes. The mean improvement in the OSA-18 total score was 34.8 (SD, 20.3;95% CI, -42.1 to -27.5) and the ESS improved by 5.1 (SD, 6.9; 95% CI, -7.4 to -2.8).

Registry

Boon et al (2018) reported results from 301 patients in the multicenter Adherence and Outcome of Upper Airway Stimulation for OSA International Registry (ADHERE).[37] The ADHERE registry included both retrospective and prospectively collected data from the U.S. and Germany between October 2016 and September 2017. Data were collected from PSG prior to implantation and between 2 and 6 months after implantation, or from home sleep tests which were often performed at 6 and 12 months after implantation as part of routine care.

Mean AHI decreased from 35.6 (SD: 15.3) to 10.2 (SD: 12.9) post-titration with 48% of patients achieving an AHI of 5 or less. ESS decreased from 11.9 (5.5) to 7.5 (4.7) (P<.001).

Kent et al (2019) pooled data from the ADHERE registry plus data from 3 other studies to evaluate factors predicting success.[38] Over 80% of the 584 patients were men, and most were overweight. Seventy seven percent of patients achieved treatment success, defined as a decrease in AHI by at least 50% and below 20 events/per hour. AHI decreased to below5 in 41.8% of patients. Greater efficacy was observed in patients with a higher preoperative AHI, older patient age, and lower BMI. A report of data from the ADHERE registry by Thaler et al (2020) included 640 patients with 6-month follow-up and 382 with 12-month follow-up.[39] AHI was reduced from 35.8 at baseline to 14.2 at 12 months (p <.001), although the number of hours of use during the sleep test was not reported and home sleep studies may underestimate AHI. ESS was reduced from 11.4 at baseline to 7.2 at 12 months (p <.001), and patient satisfaction was high. In a multivariate model, only female sex (odds ratio: 3.634, p =.004) and lower BMI (odds ratio: 0.913, p =.011) were significant predictors of response according to the Sher criteria. In sensitivity analysis, higher baseline AHI was also found to be a negative predictor of success.

In a retrospective analysis by Huntley et al (2018) of procedures at 2 academic institutions, patients with a body mass index (BMI) of greater than 32 did not have lower success rates than patients with a BMI less than 32.[40] However, only patients who had palpable cervical landmarks and carried most of their weight in the waist and hips were offered HGNS. Therefore, findings from this study are limited to this select group of patients with BMI greater than 32.

Section Summary: Hypoglossal Nerve Stimulation
The evidence on HNS for the treatment of OSA includes a systemic review, 1 RCT, nonrandomized prospective studies, nonrandomized studies with historical controls and prospective single arm studies. An RCT of 89 adults with moderate-to-severe OSA who did not tolerate CPAP found significant short-term improvement in AHI, ESS, and quality of life measures with HNS compared to sham stimulation. The study was limited by short duration of follow-up and lack of diverse individuals included in the trial. In nonrandomized studies, about two-thirds of patients with moderate-to-severe OSA who had failed conservative therapy (CPAP)and had a favorable pattern of palatal collapse met the study definition of success. Results observed at the 12-month follow-up were maintained at 5 years in the pivotal study. A prospective study that compared outcomes in patients who had received HNS to patients who were denied insurance coverage reported significant differences in both objective and subjective measures of OSA. However, there is a high potential for performance bias in this non-blinded study. For children and adolescents with OSA and Down Syndrome who are unable to tolerate CPAP, the evidence includes a safety study with 20 patients treated at tertiary care centers. The success rate was 70% with 2 adverse events of the leads; these were resolved with further surgery. A larger study of 42 individuals with Down Syndrome and OSA found a similar success rate of 73.2% with 4 device extrusions corrected with replacement surgery. Limitations of the published evidence preclude determining the effects of the technology on net health outcome.

Summary of Evidence
For individuals who have OSA who receive laser-assisted uvulopalatoplasty (LAUP) the evidence includes a single randomized controlled trial (RCT). Relevant outcomes are

symptoms, functional outcomes, quality of life, and treatment-related morbidity. The trial indicates reductions in snoring, but limited efficacy on the Apnea/Hypopnea Index (AHI) or symptoms in patients with mild-to-moderate OSA. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have OSA who receive a radiofrequency volumetric reduction of palatal tissues and base of tongue, the evidence includes 2 sham-controlled randomized trials. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Single-stage radiofrequency to palatal tissues did not improve outcomes compared to sham. Multiple sessions of radiofrequency to the palate and base of tongue did not significantly (statistically or clinically) improve AHI, and the improvement in functional outcomes were not clinically significant. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have OSA who receive palatal stiffening procedures, the evidence includes 2 sham-controlled randomized trials and several case studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The 2 RCTs differed in their inclusion criteria, with the study that excluded patients with Friedman tongue position of IV and palate of 3.5 cm or longer reporting greater improvement in AHI (45% success) and snoring (change of -4.7 on a 10-point visual analog scale) than the second trial. Additional study is needed to corroborate the results of the more successful trial and, if successful, define the appropriate selection criteria. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have OSA who receive tongue base suspension, the evidence includes a feasibility RCT with 17 patients. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. The single RCT compared tongue suspension plus uvulopalatopharyngoplasty with tongue advancement plus uvulopalatopharyngoplasty and showed success rates of 50% to 57% for both procedures. RCTs with a larger number of subjects are needed to determine whether tongue suspension alone or added to uvulopalatopharyngoplasty improves the net health outcome. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have OSA who receive hypoglossal nerve stimulation, the evidence includes a systematic review, nonrandomized prospective studies, nonrandomized studies with historical controls, and prospective single-arm studies. Relevant outcomes are symptoms, functional outcomes, quality of life, and treatment-related morbidity. Hypoglossal nerve stimulation has shown success rates for about two thirds of a subset of patients who met inclusion criteria that included AHI, body mass index, and favorable pattern of palatal collapse. These results were maintained out to 5 years in the pivotal single arm study. The single prospective comparative study of patients who received HNS versus patients who were denied insurance coverage for the procedure has a high potential for performance bias. For children and adolescents with OSA and Down Syndrome who are unable to tolerate CPAP, the evidence includes a safety study with 20 patients who were treated at tertiary care centers. The success rate was 70% with 2 adverse events of the leads, which were resolved with further surgery. Limitations of the current evidence base preclude determination of who is most likely to benefit from this invasive procedure. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

SUPPLEMENTAL INFORMATION

2018 Input

BCBSA sought clinical input (2018) to help determine whether the use of hypoglossal nerve stimulation for individuals with (OSA) would provide a clinically meaningful improvement in net health outcome and whether the use is consistent with generally accepted medical practice. In response to requests, BCBSA received clinical input from 2 respondents, including 1 specialty society-level response and physicians with academic medical center affiliation.

For individuals who have OSA who receive HNS, clinical input supports that this use provides a clinically meaningful improvement in net health outcome and indicates this use is consistent with generally accepted medical practice in subgroups of appropriately selected patients. One subgroup includes adult patients with a favorable pattern of non-concentric palatal collapse. The alternative treatment for this anatomical endotype is maxillo-mandibular advancement (MMA), which is associated with greater morbidity and lower patient acceptance than HNS. The improvement in AHI with HNS, as shown in the STAR trial, is similar to the improvement in AHI following MMA. Another subgroup includes appropriately selected adolescents with OSA and Down's syndrome who have difficulty in using CPAP. The following patient selection criteria are based on information from clinical study populations and clinical expert opinion.

- Age ≥ 22 years in adults or adolescents with Down's syndrome age 10 to 21; AND
- Diagnosed moderate to severe OSA (with less than 25% central apneas); AND
- CPAP failure or inability to tolerate CPAP; AND
- Body mass index ≤ 32 kg/m2 in adults; AND
- Favorable pattern of palatal collapse

Practice Guidelines and Position Statements

American Academy of Sleep Medicine

The American Academy of Sleep Medicine (AASM, 2021) published practice guidelines on when to refer patients for surgical modifications of the upper airway for OSA. [41] These guidelines replaced the 2010 practice parameters for surgical modifications. [42] The AASM guidelines note that positive airway pressure (PAP) is the most efficacious treatment for OSA, but effectiveness can be compromised when patients are unable to adhere to therapy or obtain an adequate benefit, which is when surgical management may be indicated. The AASM guideline recommendations are based on a systematic review and meta-analysis of 274 studies of surgical interventions, including procedures such as uvulopalatopharyngoplasty (UPPP), modified UPPP, MMA, tongue base suspension, and hypoglossal nerve stimulation. [43] The systematic review deemed most included data of low quality, consisting of mostly observational data. The AASM strongly recommends that clinicians discuss referral to a sleep surgeon with adults with OSA and body mass index (BMI) <40 kg/m2 who are intolerant or unaccepting of PAP. Clinically meaningful and beneficial differences in nearly all critical outcomes, including a decrease in excessive sleepiness, improved quality of life (QOL), improved Apnea/Hypopnea Index (AHI) or respiratory disturbance index (RDI), and sleep quality, were demonstrated with surgical management inpatients who are intolerant or unaccepting of PAP. The AASM makes a conditional recommendation that clinicians discuss referral to a sleep surgeon with adults with OSA, BMI <40 kg/m2, and persistent inadequate

adherence due to pressure-related side effects, as available data (very low-quality), suggests that upper airway surgery has a moderate effect in reducing minimum therapeutic PAP level and increasing PAP adherence. In adults with OSA and obesity (class II/III, BMI ≥ 35) who are intolerant or unaccepting of PAP, the AASM strongly recommends discussion of referral to a bariatric surgeon, along with other weight-loss strategies.

American Academy of Pediatrics

The American Academy of Pediatrics (2012) published a clinical practice guideline on the diagnosis and management of childhood OSA.[44] The Academy indicated that if a child has OSA, a clinical examination consistent with adenotonsillar hypertrophy, and does not have a contraindication to surgery, the clinician should recommend adenotonsillectomy as first-line treatment. The Academy recommended that patients should be referred for CPAP management if symptoms/signs or objective evidence of OSA persist after adenotonsillectomy or if adenotonsillectomy is not performed. Weight loss was recommended in addition to other therapy if a child or adolescent with OSA is overweight or obese.

American Academy of Otolaryngology–Head and Neck Surgery

The American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS; 2014) has a revised position statement on surgical management of OSA.[45] Procedures AAO-HNS supported as effective and not considered investigational when part of a comprehensive approach in the medical and surgical management of adults with OSA include:

- tracheostomy,
- nasal and pharyngeal airway surgery,
- tonsillectomy and adenoidectomy,
- palatal advancement,
- uvulopalatopharyngoplasty,
- genioglossal advancement,
- hyoid myotomy,
- midline glossectomy,
- tongue suspension,
- maxillary and mandibular advancement.

In a 2021 position statement, AAO-HNS supported hypoglossal nerve stimulation as an effective second-line treatment of moderate to severe OSA.[46]

American Society for Metabolic and Bariatric Surgery

The American Society for Metabolic and Bariatric Surgery (2012) published guidelines on the perioperative management of OSA.[47] The guideline indicated that OSA is strongly associated with obesity, with the incidence of OSA in the morbidly obese population reported as between 38% and 88%. The Society recommended bariatric surgery as the initial treatment of choice for OSA in this population, as opposed to surgical procedures directed at the mandible or tissues of the palate. The updated 2017 guidelines reaffirmed these recommendations.[48]

U.S. Preventive Services Task Force Recommendations

Not applicable.

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 36.

Table 36. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT02413970a	Inspire® Upper Airway Stimulation System (UAS): Post-Approval Study Protocol Number 2014-001	127	Jun 2025
NCT03868618a	A Multicenter Study to Assess the Safety and Effectiveness of the Genio Dual-sided Hypoglossal Nerve Stimulation System for the Treatment of Obstructive Sleep Apnea in Adults Subjects	134	Jun 2027
NCT02263859a	ImThera Medical Targeted Hypoglossal Neurostimulation Study #3 (THN3)	138	Dec 2022
NCT03763682a	A Multicentre, Prospective, Open-label, 2 Groups Study to Assess the Safety and Performance of the Genio™ Bilateral Hypoglossal Nerve Stimulation System for the Treatment of Obstructive Sleep Apnoea in Adult Patients With and Without Complete Concentric Collapse of the Soft Palate	42	Dec 2023
NCT04801771a	Effects of Hypoglossal Nerve Stimulation on Cognition and Language in Down Syndrome and Obstructive Sleep Apnea	68	Mar 2025
NCT04031040a	A Post-market Clinical Follow up of the Genio™ System for the Treatment of Obstructive Sleep Apnea in Adults (EliSA)	110	Oct 2025
NCT02907398a	Adherence and Outcome of Upper Airway Stimulation (UAS) for OSA International Registry	5000	Sep 2025
NCT04950894a	Treating Obstructive Sleep Apnea Using Targeted Hypoglossal Neurostimulation	150	Jul 2023
NCT04928404	Barbed Suspension of the Tongue Base for Treatment of Obstructive Sleep Apnea Patients	13	Dec 2022
Unpublished			
NCT03760328	Effect of Upper Airway Stimulation: A Randomized Controlled Crossover Study	100	Sep 2020
NCT03359096	Cardiovascular Endpoints for Obstructive Sleep Apnea With Twelfth Nerve Stimulation (CARDIOSA-12): A Randomized, Sham-Controlled, Double- Blinded, Crossover Trial	63	Jan 2022

NCT: national clinical trial.
[a] Denotes industry-sponsored or cosponsored trial.

Government Regulations

National:

There is no NCD addressing surgical treatment for obstructive sleep apnea.

Local:

Wisconsin Physicians Service Insurance Corporation
L34526 Surgical Treatment of Obstructive Sleep Apnea (OSA)
Original effective date 10/01/2015; Revision effective date 7/29/2021

Sleep-Disordered Breathing, often referred to as Obstructive Sleep Apnea (OSA), is characterized by frequent episodes of hypopnea or apnea during sleep. Multiple detrimental physiologic changes may result from these hypopneic and apneic episodes. Non-surgical and surgical approaches to obstructive apnea and hypopnea have been developed.

Continuous Positive Airway Pressure (CPAP) breathing is the treatment of choice for OSA. Some patients do not tolerate CPAP or are not benefited from it. The level of obstruction in OSA (retropalatal, retrolingual, and retropalatal and retrolingual) is variable.

Uvulopalatopharyngoplasty (UPPP) is an accepted means of surgical treatment for this disorder but is curative in less than 50% of patients. Scientific evidence suggests that UPPP is useful in retropalatal and combination retropalatal and retrolingual obstruction.

Mandibular Maxillary Osteotomy and Advancement is a procedure developed for those patients with retrolingual obstruction, or those patients with retropalatal and retrolingual obstruction who have not responded to CPAP and uvulopalatopharyngoplasty. Medical data on the efficacy of this treatment has been reported from only a small number of centers, but the information appears to show good results for those patients who meet certain criteria. It is unknown whether the technique will result in similar results outside specialized centers.

Tracheostomy remains the surgical approach with the greatest effectiveness since it bypasses all areas of obstruction in the nasal, palatal, lingual, and pharyngeal areas. However, tracheostomy is associated with significant morbidity, and is usually reserved for patients who have failed other medical or surgical methods of treatment, or who are unsuitable for other methods of treatment for various reasons.

Various other anatomic abnormalities (such as, but not limited to, enlarged tonsils or tongue) sometimes cause OSA also. Surgical approaches to these abnormalities will vary according to the anatomic defect and the procedure/procedures needed to correct the defined problem.

Genioglossal advancement, with or without resuspension of the hyoid bone, may be performed with uvulopalatopharyngoplasty, but this procedure is not always successful, and there is little definitive information on its benefit.

A. Uvulopalatopharyngoplasty (UPPP) is covered for those patients who have **all** of the following:
    1. Obstructive sleep apnea diagnosed (prior to any proposed surgery) in a certified sleep disorders laboratory (certification body recognized by the American Academy of Sleep Medicine)
    2. A Respiratory Disturbance Index of 15 or higher
    3. Failed to respond to Continuous Positive Airway Pressure therapy or cannot tolerate CPAP or other appropriate non-invasive treatment
    4. Documented counseling by a physician, with recognized training in sleep disorders, about the potential benefits and risks of the surgery; **and**
    5. Evidence of retropalatal or combination retropalatal/retrolingual obstruction as the cause of the obstructive sleep apnea

B. Mandibular Maxillary Osteotomy and Advancement and /or genioglossus advancement with or without hyoid suspension is covered for those patients who have **all** of the following
    1. Obstructive sleep apnea diagnosed (prior to any proposed surgery) in a certified sleep disorders laboratory (certification body recognized by the American Academy of Sleep Medicine)
    2. A Respiratory Disturbance Index of 15 or higher

3. Failed to respond to Continuous Positive Airway Pressure therapy or cannot tolerate CPAP or other appropriate non-invasive treatment
4. Documented counseling by a physician, with recognized training in sleep disorders, about the potential benefits and risks of the surgery; **and**
5. Evidence of retrolingual obstruction as the cause of the obstructive sleep apnea, or previous failure of UPPP to correct the obstructive sleep apnea.
   Regarding the Mandibular Maxillary Osteotomy and Advancement operation
   a. Separate repositioning of teeth would not be necessary except under unusual circumstances; but, if necessary, the dental work would be covered
   b. Application of an interdental fixation device is occasionally necessary, and is a covered service (see Documentation Requirements)

C. Tracheostomy is covered for obstructive sleep apnea that is in the judgment of the attending physician, unresponsive to other means of treatment or in cases where other means of treatment would be ineffective or not indicated.

D. When obstructive sleep apnea is caused by discrete anatomic abnormalities of the upper airway (such as, but not limited to, enlarged tonsils or an enlarged tongue), surgery to correct these abnormalities is covered if medically necessary based on adequate documentation in the medical records supporting the significant contribution of these abnormalities to OSA. Submucous radiofrequency reduction of hypertrophied turbinates is covered as an appropriate treatment for nasal obstruction due to turbinate hypertrophy that significantly contributes to OSA or significantly compromises CPAP therapy.

E. The following procedures are not covered at this time.
1. Laser-assisted uvulopalatoplasty (LAUP) is not covered at this time since it is not considered effective for OSA. LAUP **must not** be billed as 42145, Palatopharyngoplasty (e.g., uvulopalatopharyngoplasty, uvulopharyngoplasty). This code is not appropriate for this procedure. If LAUP is billed for denial purposes, it should be coded as 42299, (unlisted procedure, palate, uvula) with "LAUP" in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. The claim be denied as not proven effective.
2. Somnoplasty™ is a trade name for palate reduction with the Somnoplasty™ System of Somnus Medical Systems. This is not a term recognized by this Contractor as a covered procedure under Medicare Part B. Therefore Somnoplasty™ must not be billed as 42145. This code is not appropriate for this procedure. If Somnoplasty™ is billed for denial purposes, it should be coded as 42299, (unlisted procedure, palate, uvula) with "Somnoplasty™" in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. The claim be denied as not proven effective.
3. The Pillar Procedure™ is a trade name for palatal implants. Palatal implants have not been shown effective for the treatment of obstructive sleep apnea and are not covered. This procedure should be billed by the physician as 42299 (unlisted procedure, palate, uvula) with "Pillar Procedure™" or "palatal implant" in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. This claim will then be denied as not proven effective. Hospital outpatient would use code C9727.
4. Submucosal ablation of the tongue base, radiofrequency, one or more sites, per session. (41530) will be denied as investigational and experimental.

Wisconsin Physicians Service Insurance Corporation
L38528 Hypoglossal Nerve Stimulation for the Treatment of Obstructive Sleep Apnea (OSA) Original effective date 06/14/20; Revision effective date 4/28/22
Covered Indications
FDA-approved hypoglossal nerve neurostimulation is considered medically reasonable and necessary for the treatment of moderate to severe obstructive sleep apnea when all of the following criteria are met:

1. Beneficiary is 22 years of age or older; **and**
2. Body mass index (BMI) is less than 35 kg/m^2; **and**
3. A polysomnography (PSG) is performed within 24 months of first consultation for HGNS implant; **and**
4. Beneficiary has predominantly obstructive events (defined as central and mixed apneas less than 25% of the total AHI); **and**
5. AHI is 15 to 65 events per hour; **and**
6. Beneficiary has documentation that demonstrates CPAP failure (defined as AHI greater than 15 despite CPAP usage) or CPAP intolerance (defined as less than 4 hours per night, 5 nights per week or the CPAP has been returned) including shared decision making that the patient was intolerant of CPAP despite consultation with a sleep expert: **and**
7. Absence of complete concentric collapse at the soft palate level as seen on a drug-induced sleep endoscopy (DISE) procedure; **and**
8. No other anatomical findings that would compromise performance of device (e.g., tonsil size 3 or 4 per standardized tonsillar hypertrophy grading scale).

Limitations
The following are considered not reasonable and necessary and therefore will be denied:

1. Hypoglossal nerve neurostimulation is considered not medically reasonable and necessary for all other indications.
2. Non-FDA-approved hypoglossal nerve neurostimulation is considered not medically reasonable and necessary for the treatment of adult obstructive sleep apnea due to insufficient evidence of being safe and effective.
3. Hypoglossal nerve neurostimulation is considered not medically reasonable and necessary when any of the following contraindications are present:
    - Beneficiaries with central and mixed apneas that make up more than one-quarter of the total AHI.
    - Beneficiaries with an implantable device could experience unintended interaction with the HGNS implant system.
    - BMI equal to or greater than 35
    - Neuromuscular disease
    - Hypoglossal-nerve palsy
    - Severe restrictive or obstructive pulmonary disease
    - Moderate-to-severe pulmonary arterial hypertension
    - Severe valvular heart disease
    - New York Heart Association class III or IV heart failure
    - Recent myocardial infarction or severe cardiac arrhythmias (within the past 6 months)
    - Persistent uncontrolled hypertension despite medication use

- An active, serious mental illness that reduces the ability to carry out Activities of Daily Living (ADLs) and would interfere with the patient's ability to operate the HNS and report problems to the attending provider.
- Coexisting non-respiratory sleep disorders that would confound functional sleep assessment
- Beneficiaries who are, or who plan to become pregnant.
- Beneficiaries who require Magnetic Resonance Imaging (MRI) with model 3024.
- Beneficiaries, who require MRI with model 3028, can undergo MRI on the head and extremities if certain conditions and precautions are met. Please refer to the Manufacturer Guidelines for this model and future models for more information.
- Beneficiaries who are unable or do not have the necessary assistance to operate the sleep remote.
- Beneficiaries with any condition or procedure that has compromised neurological control of the upper airway.

4. Drug Induced Sleep Endoscopy (DISE):
   - Due to documented inconsistency in determining if complete concentric collapse (CCC) is present, the inserting provider shall be certified by the FDA approved manufacturer's second opinion service of validation via video clip submissions of at least 80% agreement in at least 15 consecutive studies. Inserting providers shall have documentation to submit to this contractor if necessary.
5. Shared Decision Making (SDM):
   - SDM shall be documented in the patient's record by the referring physician and the implanting physician. Both shall provide these documents if requested by this contractor.

Wisconsin Physicians Service Insurance Corporation
A56905 Billing and Coding: Surgical Treatment of Obstructive Sleep Apnea (OSA)
Original Effective Date: 08/29/19 Revision Effective Date: 1/1/23
The billing and coding information in this article is dependent on the coverage indications, limitations and/or medical necessity described in the associated LCD L34526.

Sleep-Disordered Breathing, often referred to as OBSTRUCTIVE SLEEP APNEA (OSA), is characterized by frequent episodes of hypopnea or apnea during sleep. Multiple detrimental physiologic changes may result from these hypopneic and apneic episodes. Non-surgical and surgical approaches to obstructive apnea and hypopnea have been developed.
The following procedures are not covered at this time.

1. Laser-assisted uvulopalatoplasty (LAUP) is not covered at this time since it is not considered effective for OSA. LAUP must not be billed as 42145, Palatopharyngoplasty (e.g., uvulopalatopharyngoplasty, uvulopharyngoplasty). This code is not appropriate for this procedure. If LAUP is billed for denial purposes, it should be coded as 42299, (unlisted procedure, palate, uvula) with "LAUP" in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. The claim will be denied as not proven effective.
2. Somnoplasty™ is a trade name for palate reduction with the Somnoplasty™ System of Somnus Medical Systems. This is not a term recognized by this Contractor as a covered procedure under Medicare Part B. Therefore Somnoplasty™ must not be billed as 42145. This code is not appropriate for this procedure. If Somnoplasty™ is billed for denial purposes, it should be coded as 42299, (unlisted procedure, palate, uvula) with

"Somnoplasty™" in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. This claim will be denied as not proven effective.

3. The Pillar Procedure™ is a trade name for palatal implants. Palatal implants have not been shown effective for the treatment of OBSTRUCTIVE SLEEP APNEA and are not covered. This procedure should be billed by the physician as 42299 (unlisted procedure, palate, uvula) with “Pillar Procedure™” or “palatal implant” in the electronic narrative 2400/SV101-7 equivalent to line 19 of the CMS 1500 form. This claim will then be denied as not proven effective. Hospital outpatient departments would use code C9727.
4. Submucosal ablation of the tongue base, radiofrequency, one or more sites, per session. (41530) will be denied as investigational and experimental.

Wisconsin Physicians Service Insurance Corporation
A57944 Billing and Coding: Hypoglossal Nerve Stimulation for Treatment of Obstructive Sleep Apnea. Original Effective Date: 06/14/20 Revision Effective Date: 4/28/22

Refer to the Proposed Local Coverage Determination (LCD) DL38528, **HYPOGLOSSAL NERVE STIMULATION FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA**, for reasonable and necessary requirements.

The Current Procedural Terminology (CPT)/Healthcare Common Procedure Coding System (HCPCS) code(s) may be subject to National Correct Coding Initiative (NCCI) edits. This information does not take precedence over NCCI edits. Please refer to NCCI for correct coding guidelines and specific applicable code combinations prior to billing Medicare.

Coding Guidelines
Implantation of a Hypoglossal Nerve Stimulator (HSN) for treatment of OSA CPT code:

- **CPT code 64582** - Open implantation of hypoglossal nerve neurostimulator array, pulse generator, and distal respiratory sensor electrode or electrode array

Revision or replacement of HSN for treatment of OSA is reported with:

- **CPT code 64583** - Revision or replacement of hypoglossal nerve neurostimulator array and distal respiratory sensor electrode or electrode array, including connection to existing pulse generator

Reduced services-Use modifier 52 for revision or replacement of either the hypoglossal nerve stimulator electrode array or distal respiratory sensor, and bill at a reduced rate.

Removal of HSN for treatment of OSA is reported with:

- **CPT code 64584** - Removal of hypoglossal nerve neurostimulator array, pulse generator, and distal respiratory sensor electrode array

Reduced services- Use modifier 52 for removal of one or two components of the hypoglossal nerve stimulator electrode array, pulse generator, or distal respiratory sensor, and bill at a reduced rate.

Coding Guidance

- Do not bill CPT code 64582 in conjunction with 64583, 64584, or 61888
- Do not bill CPT code 64583 in conjunction with 64582, 64584, or 61888
- Do not bill CPT code 64584 in conjunction with 64582, 64583, or 61888

Documentation Requirements

1. All documentation must be maintained in the patient's medical record and made available to the contractor upon request.
2. Every page of the record must be legible and include appropriate patient identification information (e.g., complete name, dates of service[s]). The documentation must include the legible signature of the physician or non-physician practitioner responsible for and providing the care to the patient.
3. The submitted medical record must support the use of the selected diagnosis code(s).

(The above Medicare information is current as of the review date for this policy. However, the coverage issues and policies maintained by the Centers for Medicare & Medicare Services [CMS, formerly HCFA] are updated and/or revised periodically. Therefore, the most current CMS information may not be contained in this document. For the most current information, the reader should contact an official Medicare source.)

Related Policies

- Actigraphy for Obstructive Sleep Apnea
- Cosmetic and Reconstructive Surgery
- Positive Pressure Airway Devices
- Diagnosis Sleep Disorders
- Medical Management of Obstructive Sleep Apnea Syndrome (Oral Appliances and Novel Therapies)

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The articles reviewed in this research include those obtained in an Internet based literature search for relevant medical references through March 2023, the date the research was completed.

Joint BCBSM/BCN Medical Policy History

Policy Effective Date	BCBSM Signature Date	BCN Signature Date	Comments
7/10/02	7/10/02	7/10/02	Joint policy established
1/22/04	1/22/04	3/1/04	Routine maintenance
5/7/04	5/7/04	6/22/04	Addition of procedure codes and descriptions
1/14/05	1/14/05	1/14/05	Code updated effective 1/1/05
7/15/05	7/15/05	9/22/05	Routine maintenance
1/1/08	10/16/07	11/15/07	Routine maintenance
5/1/09	2/10/09	2/10/09	Routine maintenance
1/1/11	10/12/10	10/27/10	Routine maintenance; removed codes E0485 and E0486
7/1/12	6/7/12	5/18/12	Routine maintenance
5/1/14	2/18/14	3/3/14	Routine maintenance; added “and Snoring” to the policy title; added “All other minimally-invasive surgical procedures not described above” to the exclusions.
7/1/16	4/19/16	4/19/16	Routine maintenance Hypoglossal nerve stimulation added to exclusions References and rationale updated
7/1/17	4/18/17	4/18/17	Routine maintenance Added procedure codes 0466T-0468T References and rationale updated
7/1/18	4/17/18	4/17/18	Routine maintenance Added procedure codes 21685 and 64568.
5/1/19	2/19/19		Routine maintenance Position change: HNS covered with criteria.
5/1/20	2/18/20		Routine maintenance. Ref #13 and 24 added.

5/1/21	3/2/21		Routine maintenance. Ref #4, 27, 28, 29, 30, 37, and 38 added. Added LCD L38528 and A57944. Updated change to Inspire HGNS under Table 1: Inspire HGNS is now also indicated for use in patients between the ages of 18 and 21 with moderate to severe OSA (AHI 15-65) who: are contraindicated for, or not effectively treated by, adenotonsillectomy - to reflect FDA language. • Added the below under inclusion under Hypoglossal nerve stimulation coverage – to reflect FDA language: • Adolescent or young-adult member: • Between the ages of 18 and 21; AND • Moderate to severe OSA (15 ≤ AHI ≤ 65); AND • Non-concentric retropalatal obstruction on drug-induced sleep endoscopy; AND • A contraindication to, or not effectively treated by, adenotonsillectomy; AND • Has been confirmed to fail, or cannot tolerate, PAP therapy despite attempts to improve compliance; AND ** • Has followed standard of care in considering all other alternative/adjunct therapies
5/1/22	2/15/22		• Routine maintenance • 0466T, 0467T and 0468T replaced with 64582, 64583, 64584
7/1/22	4/19/22		• Added code 49275 under Established. • Added the below language under the MPS: o Drug-induced sleep endoscopy (DISE) replicates sleep with an

			infusion of propofol. DISE will suggest either a flat, anterior-posterior collapse or complete circumferential oropharyngeal collapse. Concentric collapse decreases the success of hypoglossal nerve stimulation and is an exclusion criterion from the U.S. Food and Drug Administration. oThe use of the DISE procedure is considered established to evaluate appropriateness of FDA-approved hypoglossal nerve stimulation when all of the criteria for hypoglossal nerve stimulation are met. o The DISE procedure is considered experimental/investigational for all other indications. • Added the below language under Inclusions: o Drug-induced sedation endoscopy (DISE): The DISE procedure is established to evaluate the appropriateness of FDA-approved hypoglossal nerve stimulation when all the criteria for hypoglossal nerve stimulation are met. • Added the below language under Exclusions : o The DISE procedure is considered experimental/investigational for all other indications • Removed procedure code 64568 which was revised on 1/1/22 from Incision for implantation of cranial nerve (eg, vagus nerve) neurostimulator electrode array and pulse generator to Open implantation of cranial nerve (eg, vagus nerve) neurostimulator electrode array and pulse

			generator. This policy does not speak to cranial nerve. •Revised the definition of hypopnea to “at least 3% or 4% decrease in arterial oxygen saturation” in order to reflect both AASM and Medicare requirements.
7/1/23	4/18/23		• Routine Maintenance • BCBSA updated policy 7.01.101 - Surgical Treatment of Snoring and Obstructive Sleep Apnea Syndrome on 6/9/22 • References added, policy statements unchanged • Vendor: N/A (ky)

Next Review Date: 2nd Qtr, 2024

Pre-Consolidation Medical Policy History

Original Policy Date	Comments
BCN: 12/1/99	Revised: 3/14/01, 1/4/02
BCBSM: 1/1/97	Revised: 11/14/00

BLUE CARE NETWORK BENEFIT COVERAGE
POLICY: OBSTRUCTIVE SLEEP APNEA AND SNORING - SURGICAL TREATMENT

I. Coverage Determination:

Commercial HMO (includes Self-Funded groups unless otherwise specified)	Policy criteria apply.
BCNA (Medicare Advantage)	See Government Regulations section. If there is no NCD or LCD, medical policy criteria apply.
BCN65 (Medicare Complementary)	Coinsurance covered if primary Medicare covers the service.

II. Administrative Guidelines:

- The member's contract must be active at the time the service is rendered.
- Coverage is based on each member's certificate and is not guaranteed. Please consult the individual member's certificate for details. Additional information regarding coverage or benefits may also be obtained through customer or provider inquiry services at BCN.
- The service must be authorized by the member's PCP except for Self-Referral Option (SRO) members seeking Tier 2 coverage.
- Services must be performed by a BCN-contracted provider, if available, except for Self-Referral Option (SRO) members seeking Tier 2 coverage.
- Payment is based on BCN payment rules, individual certificate, and certificate riders.
- Appropriate copayments will apply. Refer to certificate and applicable riders for detailed information.
- CPT - HCPCS codes are used for descriptive purposes only and are not a guarantee of coverage.