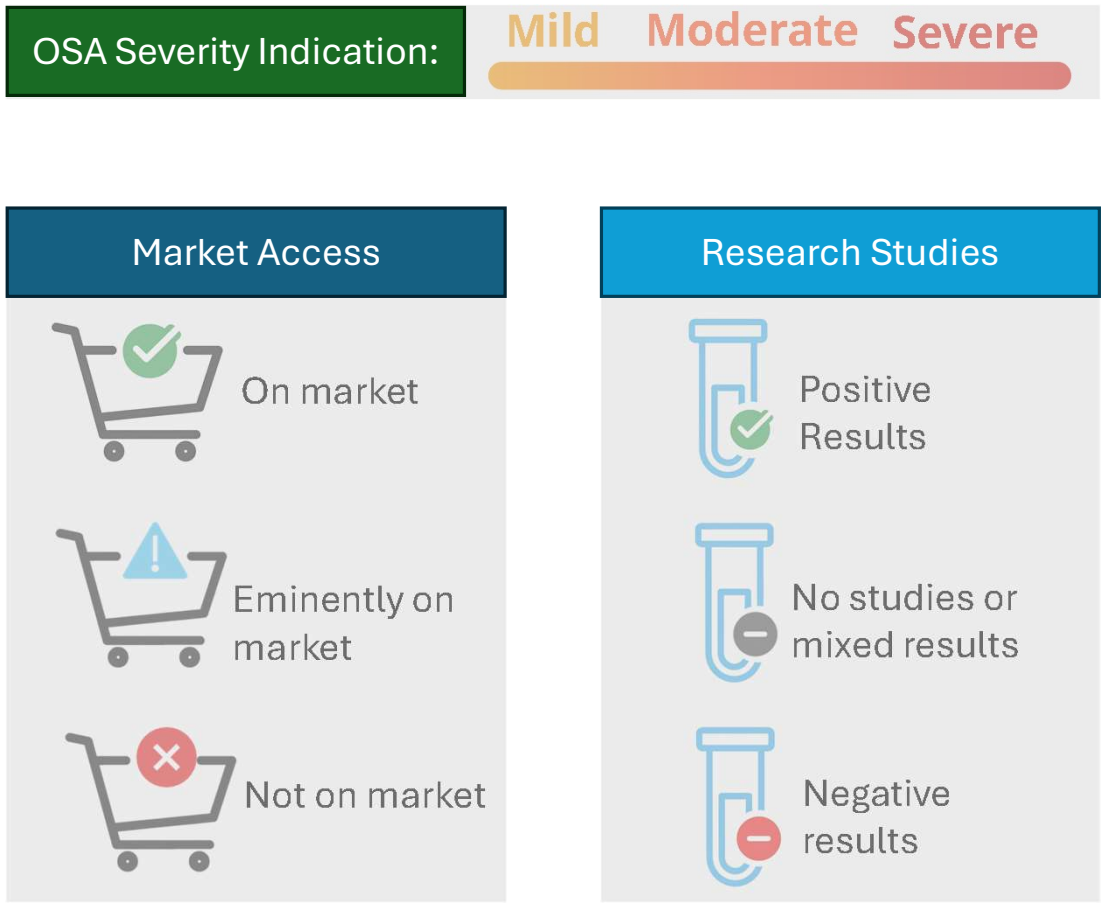
Beyond the Oral Appliance:

Navigating Technological Advances in Sleep Apnea Therapy

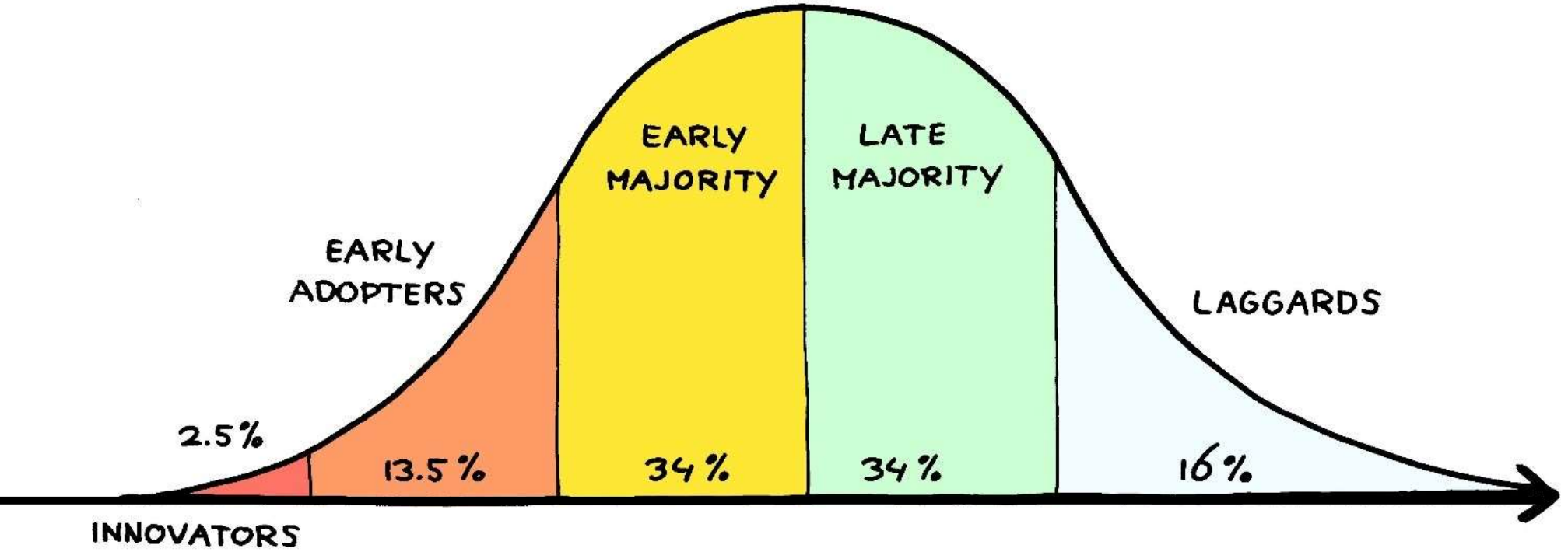
Aaron Glick, DDS, D.ABDSM

What will we talk about?

- What is emerging technology
- Emerging OSA therapies
- Closing thoughts

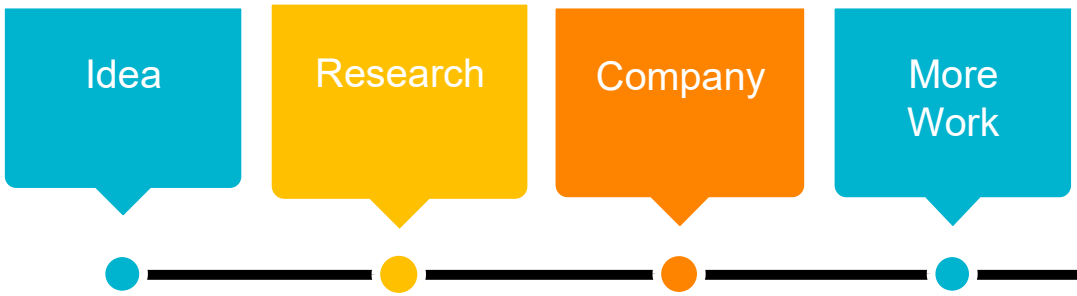


Technology Adoption Lifecycle



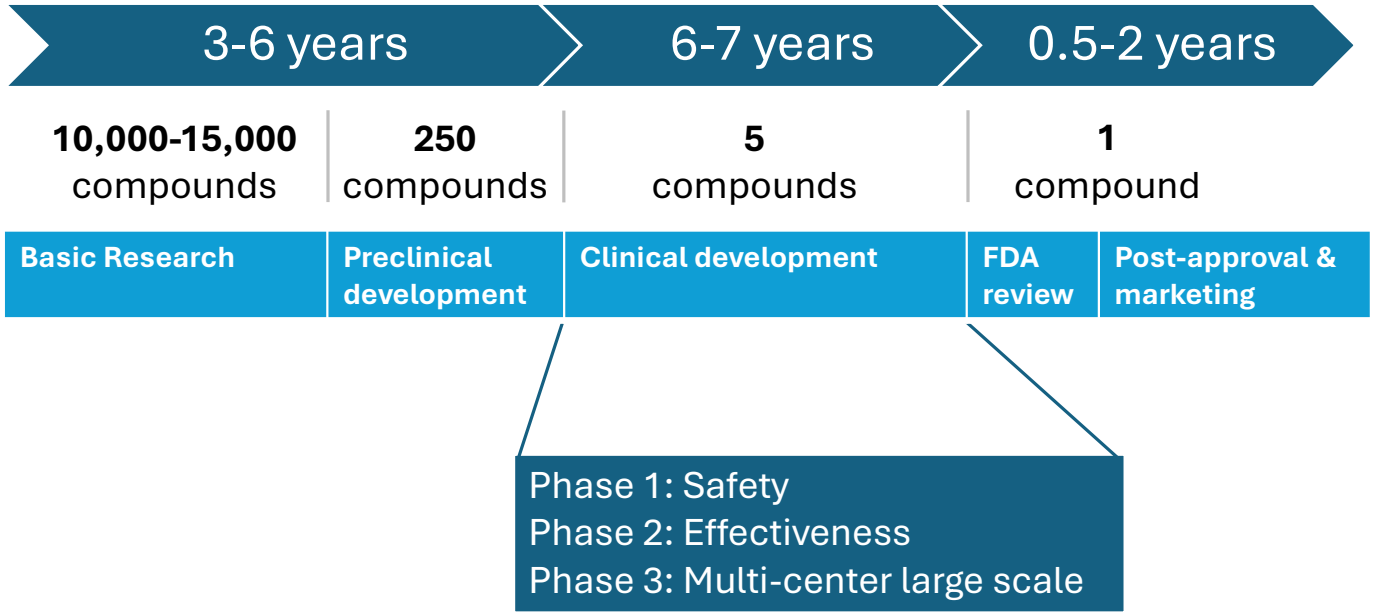
Moore 2013

Technology Adoption Lifecycle



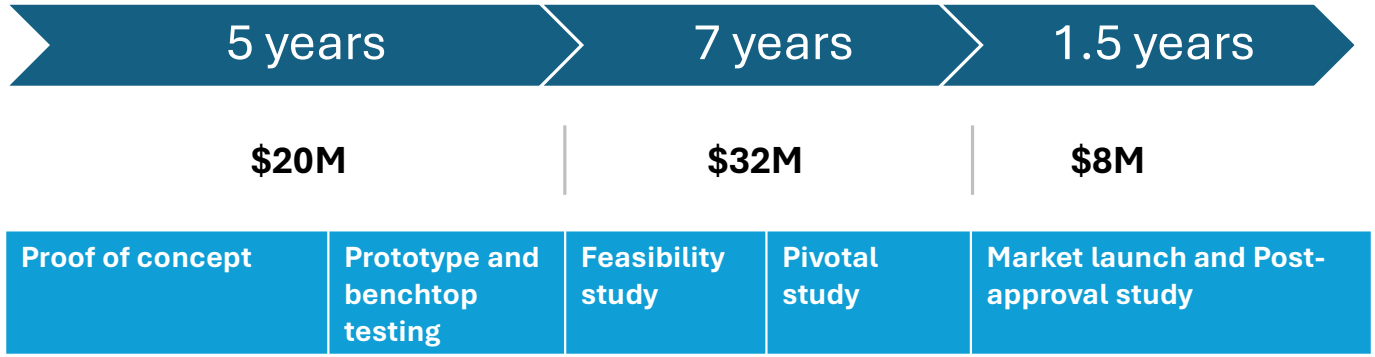
Moore 2013

FDA Drug Submissions – 505 pathway



Yamaguchi 2020
Torjensen 2015

FDA Medical Device Pathway – Class III



Sertkaya 2022

Therapeutics

Surgical Hypoglossal Nerve Stimulation
- Inspire
- Nyxoah
- Liva Nova
- StimAire

Non-Invasive Neuromodulation
- XII Medical
- Pasithea
- Restera
- WhisperSom

Tongue Mobility
- Respiosa
- Linguaflex

Hyoid Suspension
- MagNap
- Siesta Medical

Positional Sleep Apnea
- Smart Nora
- Night Balance

Soft Palate Augmentations
- Cryosa

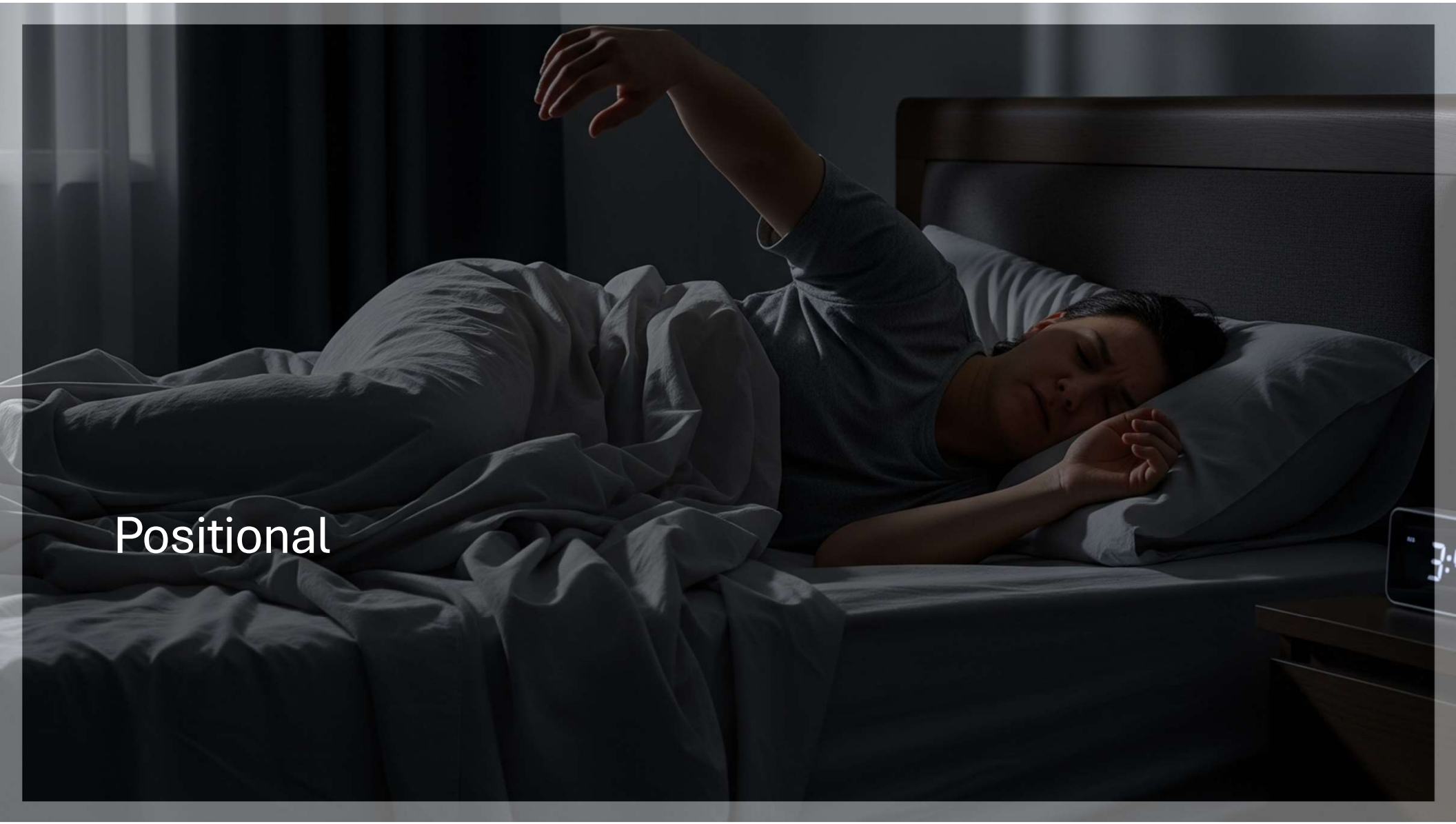
Pressures
- KPAP
- Sommetrics

Myofunctional Therapy Devices
- ExciteOSA
- REMastered Sleep

Mandibular Advancement Devices
- Somnomed
- Prosomnus
- Vivos

Pharmacology
- Eli Lilly
- Apnimed
- Chugai Pharm
- RespireRX Pharm
- Incannex

Digital Health
- Ensodata
- Ognomy
- Daybreak


Positional

Smart Nora

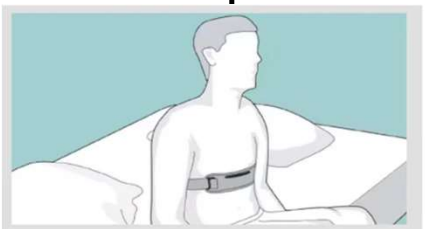
- Detects snoring and moves pillow
- Recently out of business.

Bankrupt July 2025

Consumer product. No studies found

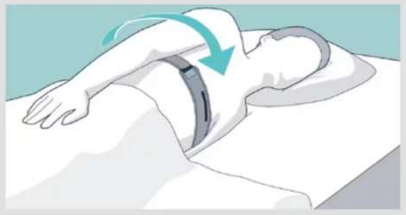
Night Balance

- Positional detector to reposition patient



Patient can fall asleep in any position. After 15 minutes, the device activates and begins monitoring.

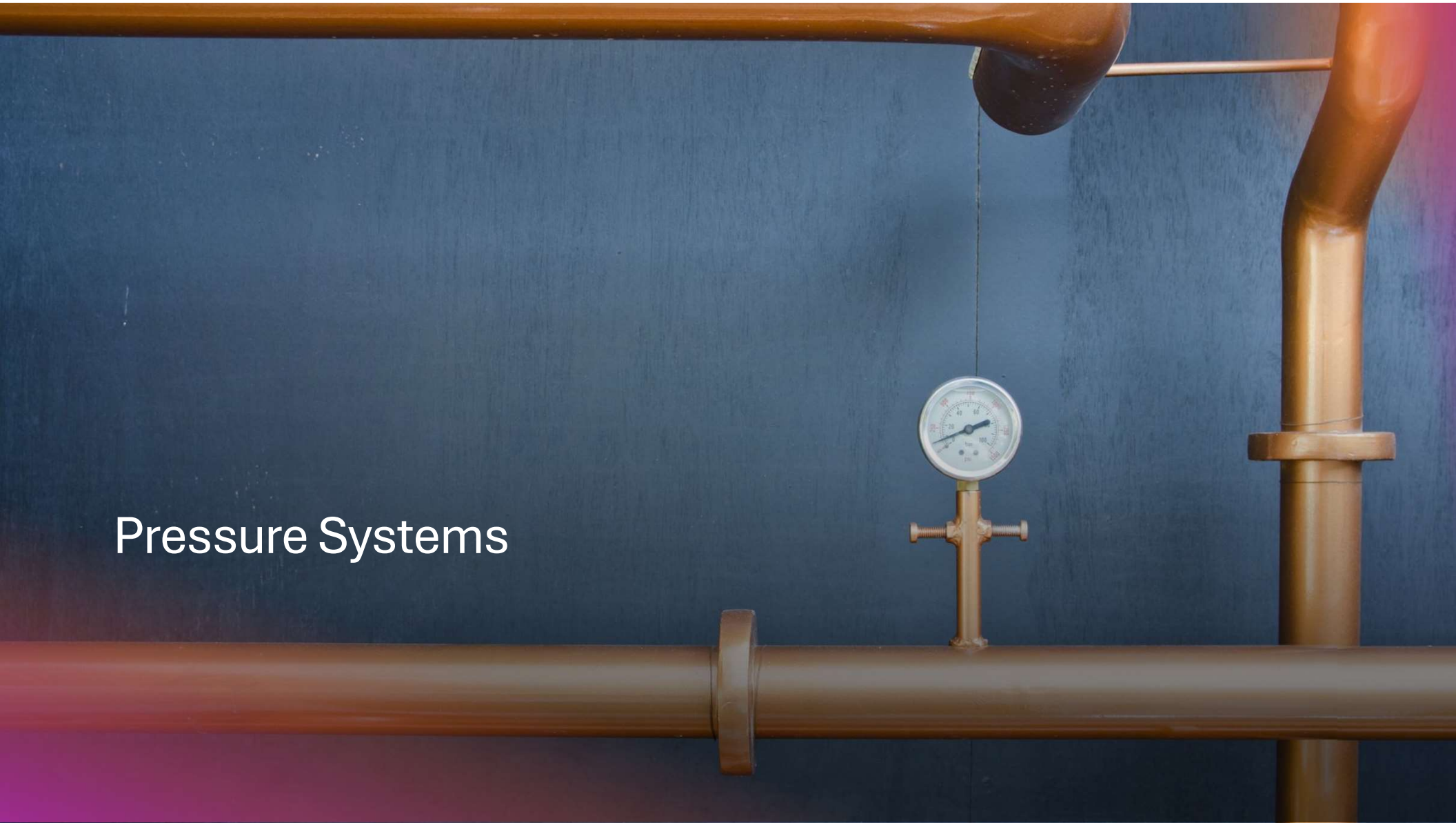
NightBalance detects when the patient is on their back. It prompts the patient to move off their back without disturbing their sleep.



Vibrations will stop when patient is on their side

Discontinued Sept 2023.

POSAtive study showed improved adherence vs. APAP. Prospective study showed 17 AHI to 9 AHI.


Pressure Systems

Resmed

- CPAP, APAP, BPAP, ASV, EPR systems
- Gold standard of care
- App for mask selection and patient engagement

On market globally

Gold standard treatment

Sommetrics

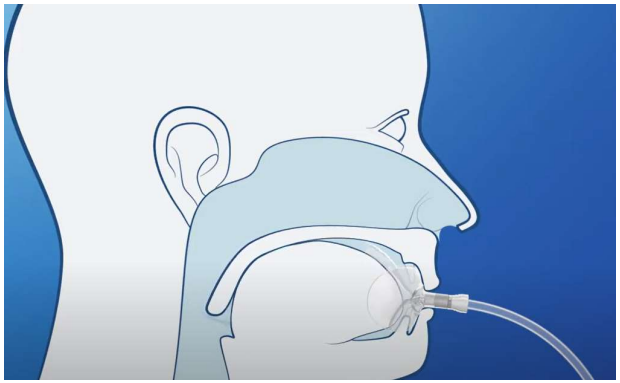
- Using aerSleep technology for external negative pressure on neck area.
- Difficult to use if you have a beard or vascular issues of the neck.

Targeting 2025 in US

2 articles with PSG. 87% responders with severe at baseline

Somnics

- iNAP system creates intraoral negative pressure with titratable pressures.
- Patients that don’t have anterior teeth, hx UPPP, or mouth breathers are not good candidates



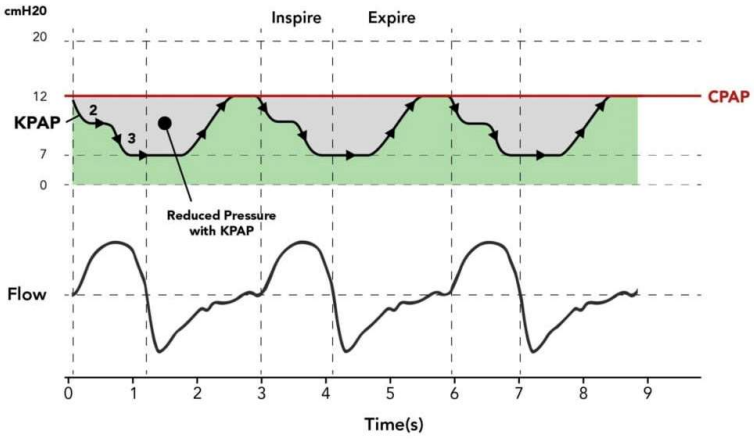
*per company

On market, company working towards increased reimbursement

Multiple articles. Approximately 80% subjects are responders in mild OSA

SleepRes

- KPAP device to adjust inspiratory and expiratory pressures to improve comfort and increase natural breathing experience.



Not yet.

Similar efficacy to CPAP.
69-84% prefer than CPAP.

Bleep

- Mask free option for PAP therapy. Adhesive affixes to nose.

On market

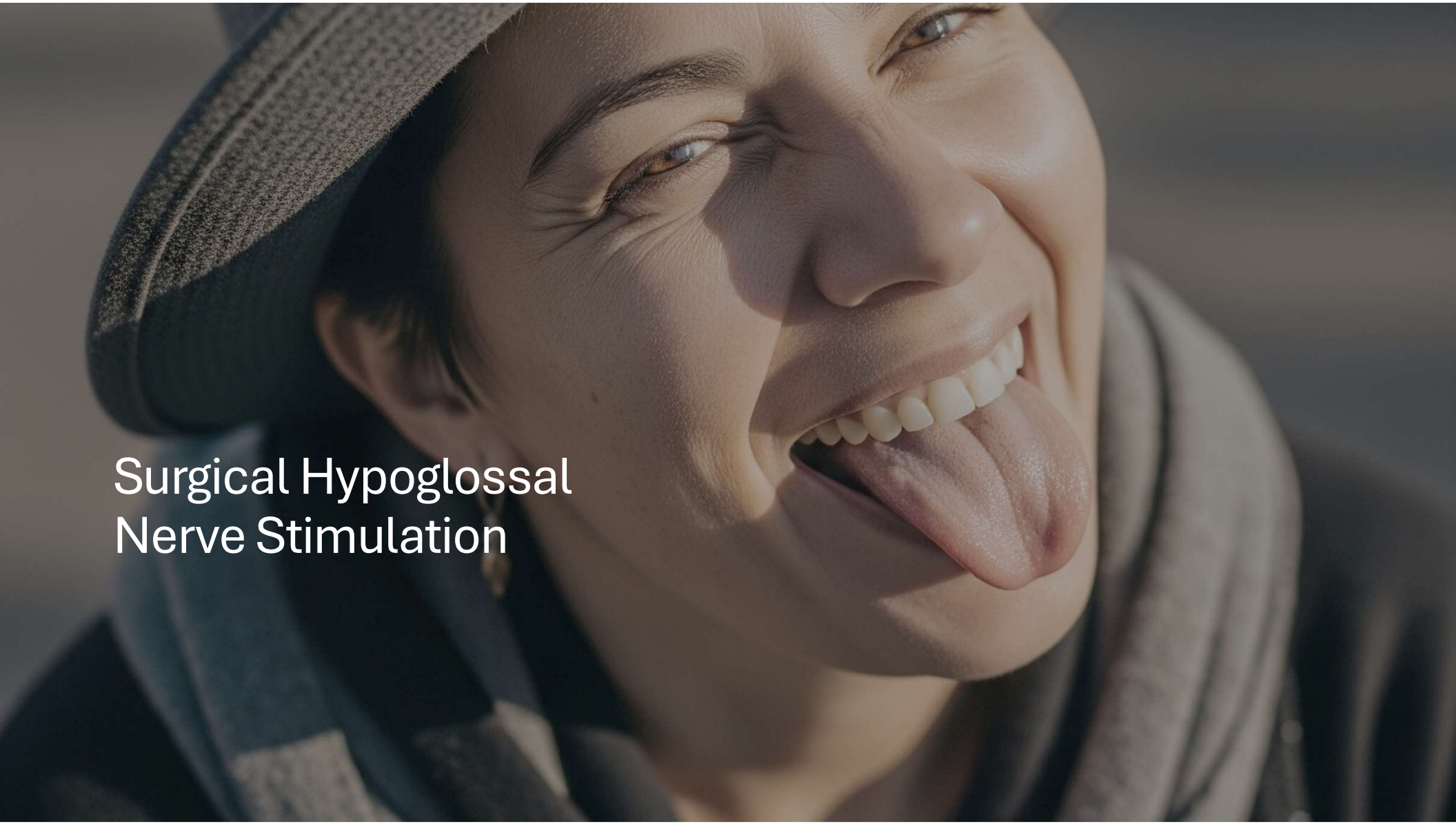
Consumer product, none found.

AirAvant Medical

- EPAP device similar to Provent

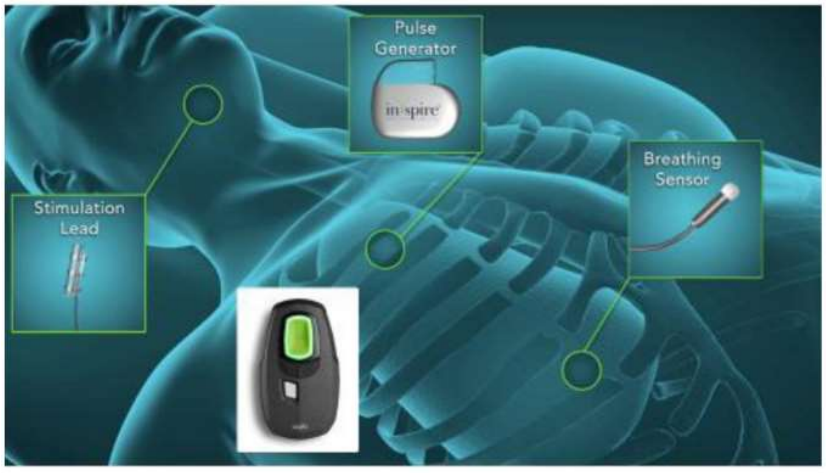
On the market

EPAP reduces AHI, yet compliance is low


Surgical Hypoglossal
Nerve Stimulation

Inspire Medical Systems

- Unilateral hypoglossal nerve stimulation with sensing lead. Placed on distal nerve.
- Incumbent in the HNS space



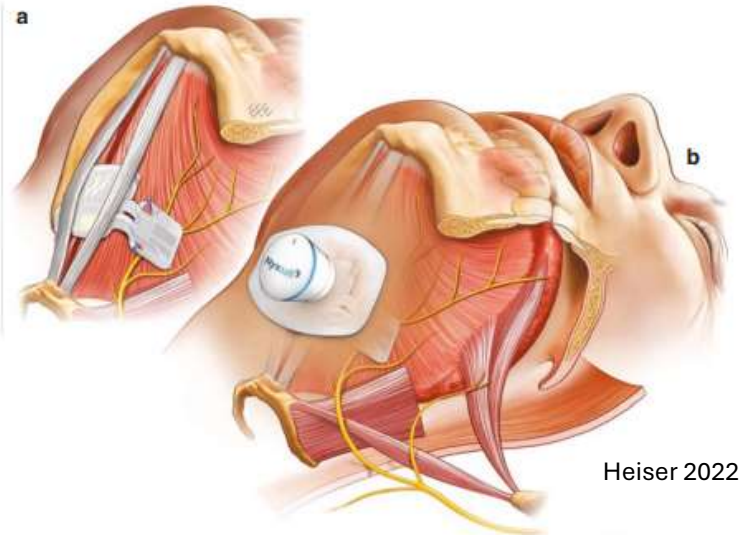
Yamauchi2023

On the market

Gold-standard HNS

Nyxoah

- Genio System with bilateral hypoglossal nerve stimulation with passive energy transcutaneously. Placed on distal nerve



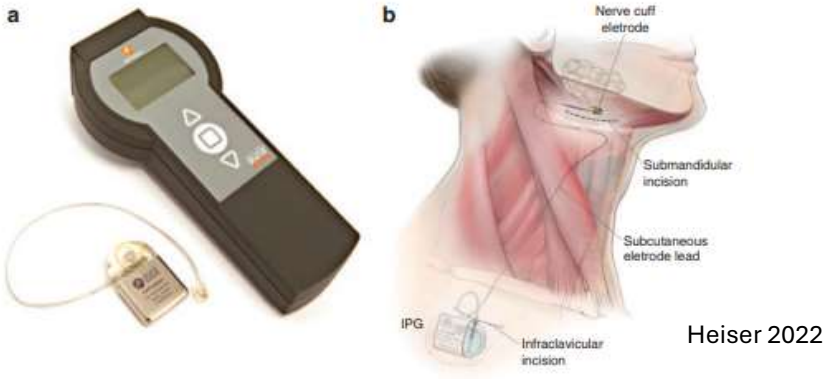
Heiser 2022

On the market. FDA approval August 2025. CE mark in 2019.

DREAM study with positive results

Liva Nova

- Aura6000 system with unilateral activation of proximal trunk of hypoglossal through complex array of stimulation patterns to reduce muscle fatigue, simultaneous activation to reduce duty cycle and maintain near continuous activation



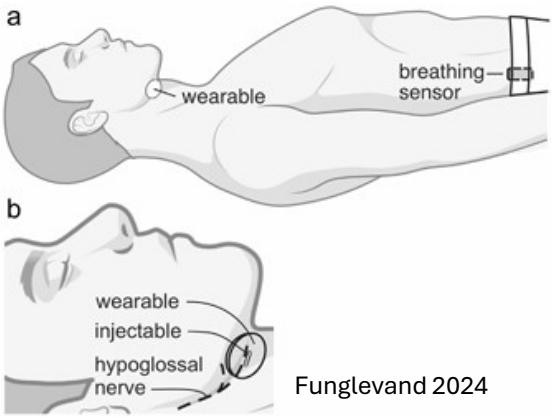
Heiser 2022

CE marked since 2012. Not on US market

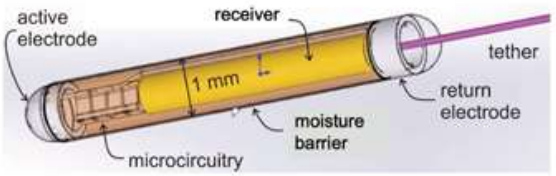
OSPREY trial beginning in 2021. 12 month data showing 65% responder rate.

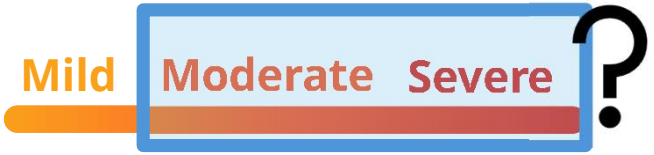
StimAire

- Injectable hypoglossal nerve stimulation for a more simple in-office procedure



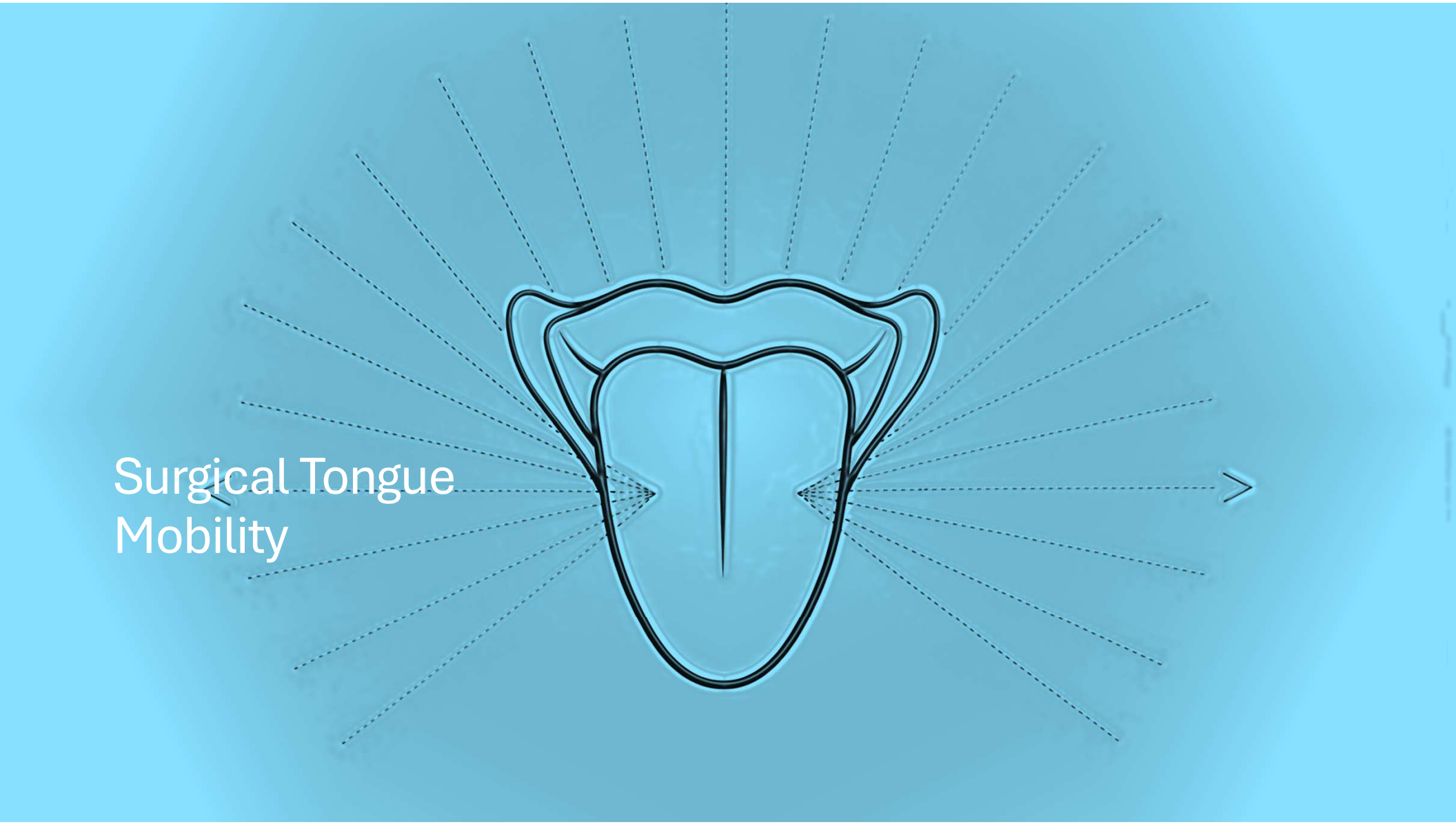
Funglevand 2024





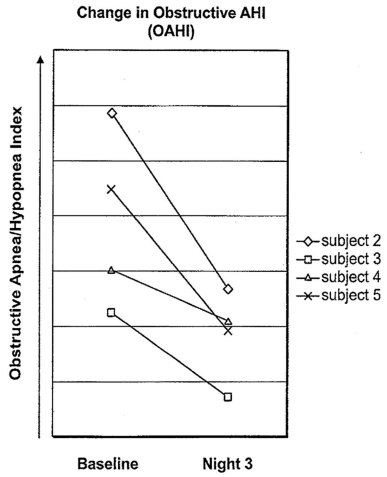
Not on the market anywhere

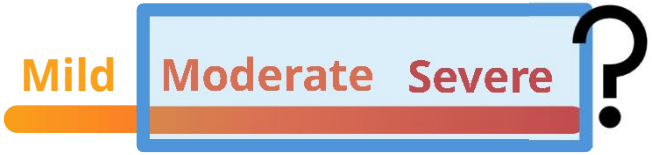
Animal studies showing stimulation in leg; FDA breakthrough designation


Surgical Tongue
Mobility

Linguaflex

- Implantable tissue retractor surgically inserted into base of tongue. Pulls anteriorly on tongue base tissue.



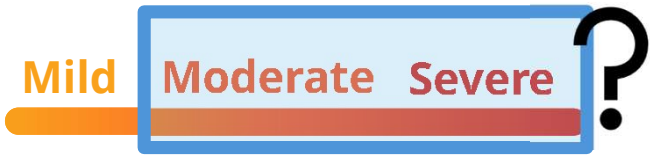


Not on the market anywhere

Showed AHI decrease in 5 subjects

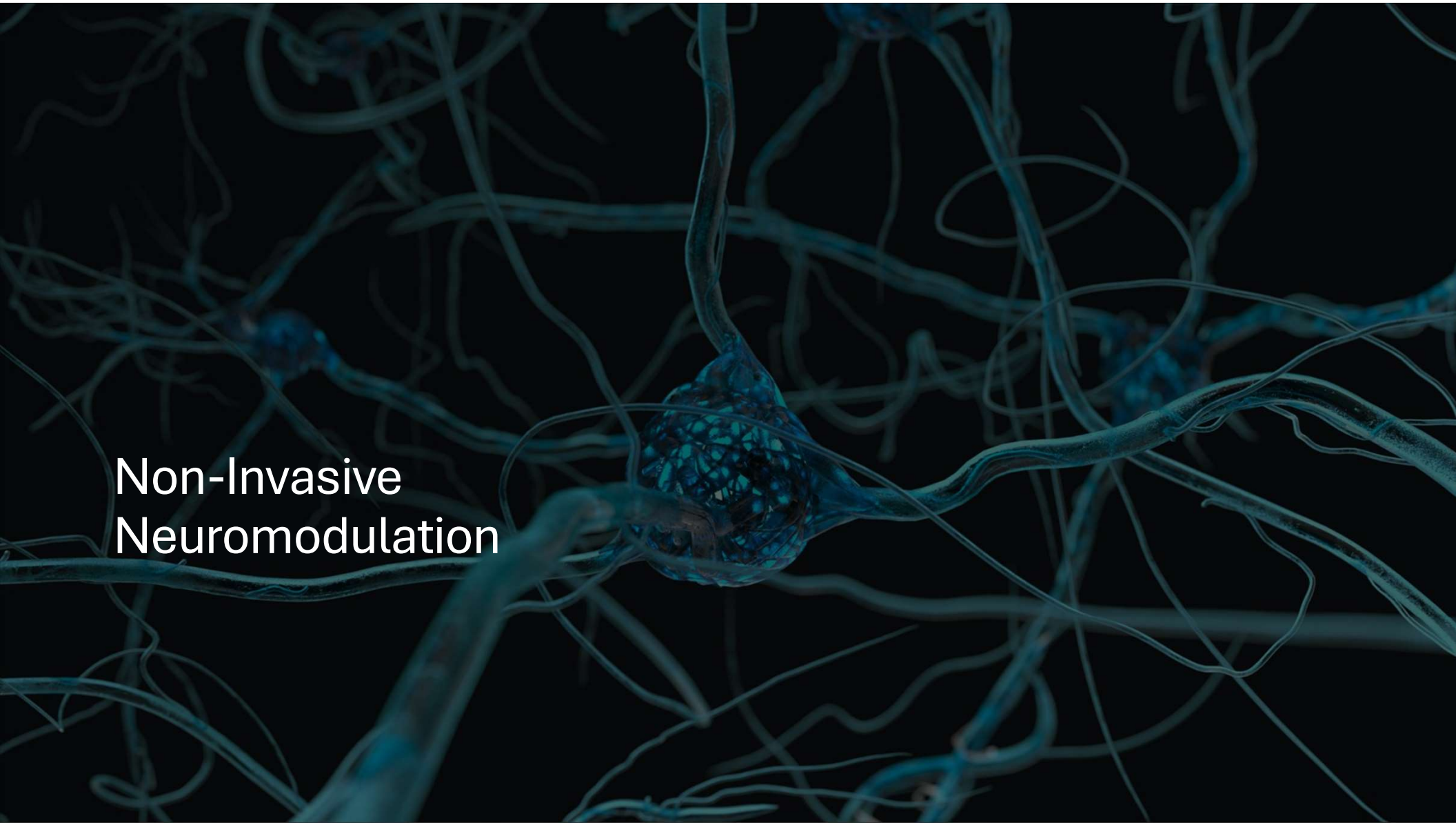
Respiosa

- Titratable tongue implant to stabilize the tongue base



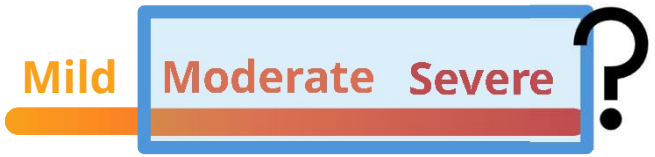
Not on the market anywhere

None found.


Non-Invasive
Neuromodulation

XII Medical

- Minimally invasive neurostimulation device

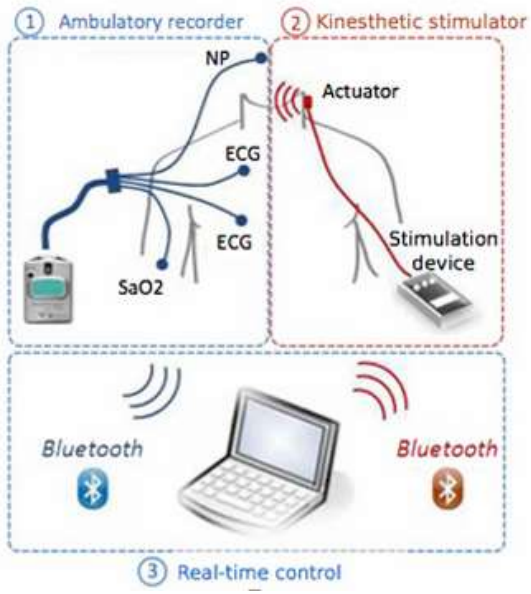


Not on the market

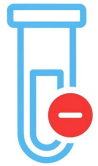
Limited published data. Enrolling for BEAT OSA trial.

Pasithea

- Uses kinesthetic stimulation



Not on the market and no movement towards this



Early data showed minor change in apnea durations

Restera

- Minimally invasive electrode for tongue stimulation

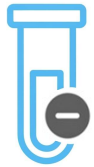
Not on the market

Feasibility of percutaneous approach and 7 cmH_2O reduction with active implant

WhisperSom

Precision acoustic neuromodulation

Not on the market

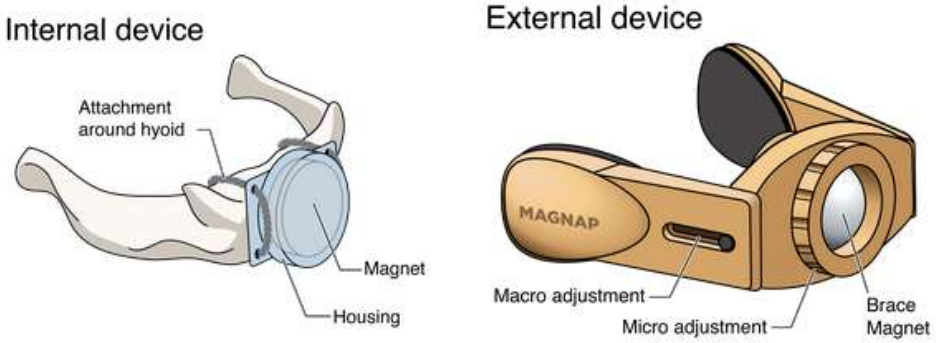


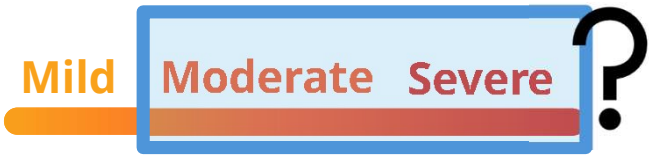
No data found

Hyoid Suspension

MagNap

- Surgical treatment to anteriorly position the hyoid through magnetic force



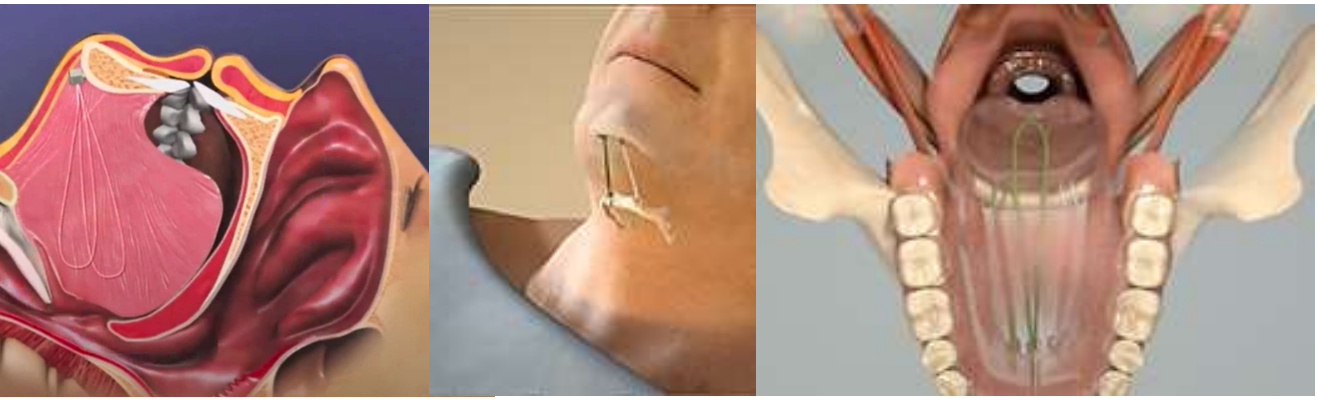


Not on the market anywhere

Enrolling 10 patients now (21-70yo)

Siesta Medical

- Airlift technology to suspend hyoid & separately tongue suspension through a tether system through surgery. It's adjustable and removable.



On the market

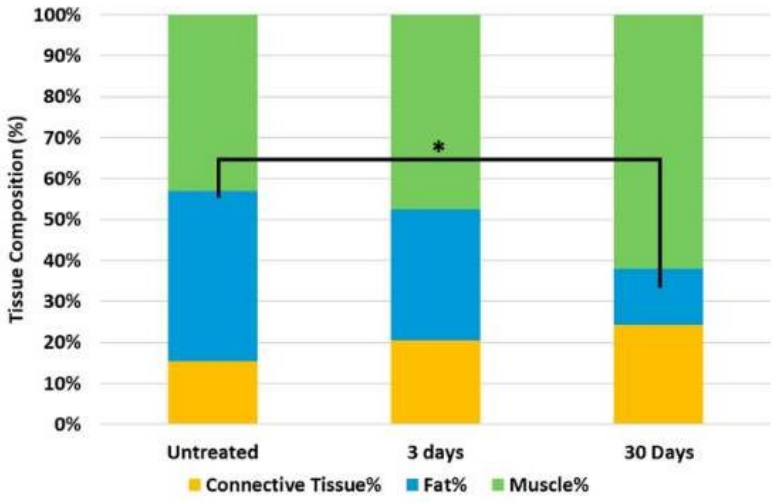
76% surgical success for hyoid suspension in moderate to severe;

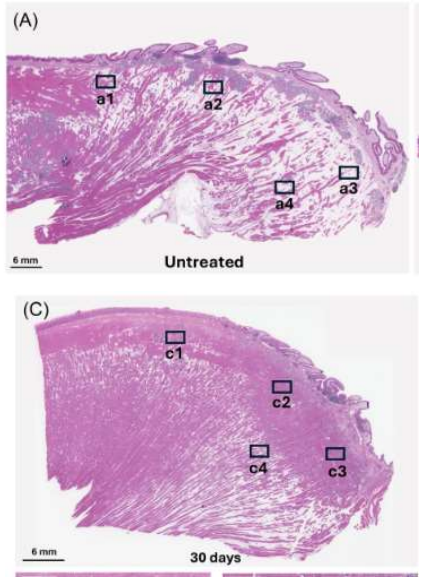
*Tongue suspension alone is 36% success.

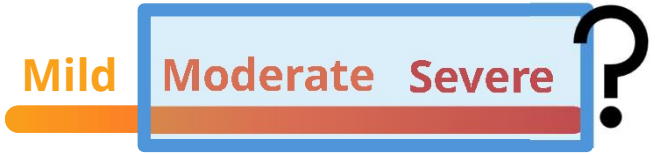

Soft Palate
Augmentations

Cryosa

- Minimally-invasive Surgical reduction of adipose tissue in soft palate through cryolysis







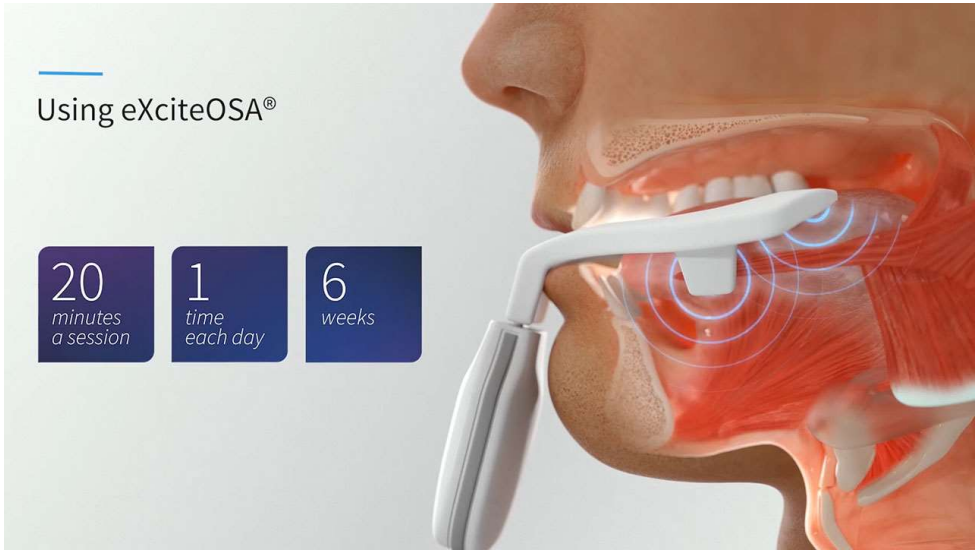
Not on the market

Treated first patient 2024. Enrolling ARTIC-3 pilot study


Myofunctional Therapy /
Daytime Devices

Signifier Medical Technologies

- eXciteOSA



On market. Reimbursed via HCPCs.

90% responders to snoring.

REMastered Sleep

- Myofunctional therapy provided through REMplenish Jr Myo-Nozzle for water bottles

On market.

34% reported improvement in tiredness. No objective testing.


Pharmacology

Elli Lilly and Company

- Zepbound (tirzepatide) injection that is a GLP-1/GIP receptor agonist used to reduce fat deposition and systemic inflammation.

- Orforglipron (GLP-1 receptor agonist) discovered by Chugai Pharmaceutical for obesity in ATTAIN phase 3 clinical trial (27lbs / 12% weight loss). Will be studied for OSA.

FDA approved in late 2024

After 52 weeks significant decrease in AHI for Zepbound; 42% treated (SURMOUNT)

Side effects

Received: 7 November 2024 | Revised: 28 January 2025 | Accepted: 4 February 2025
DOI: 10.1111/dom.16275

ORIGINAL ARTICLE

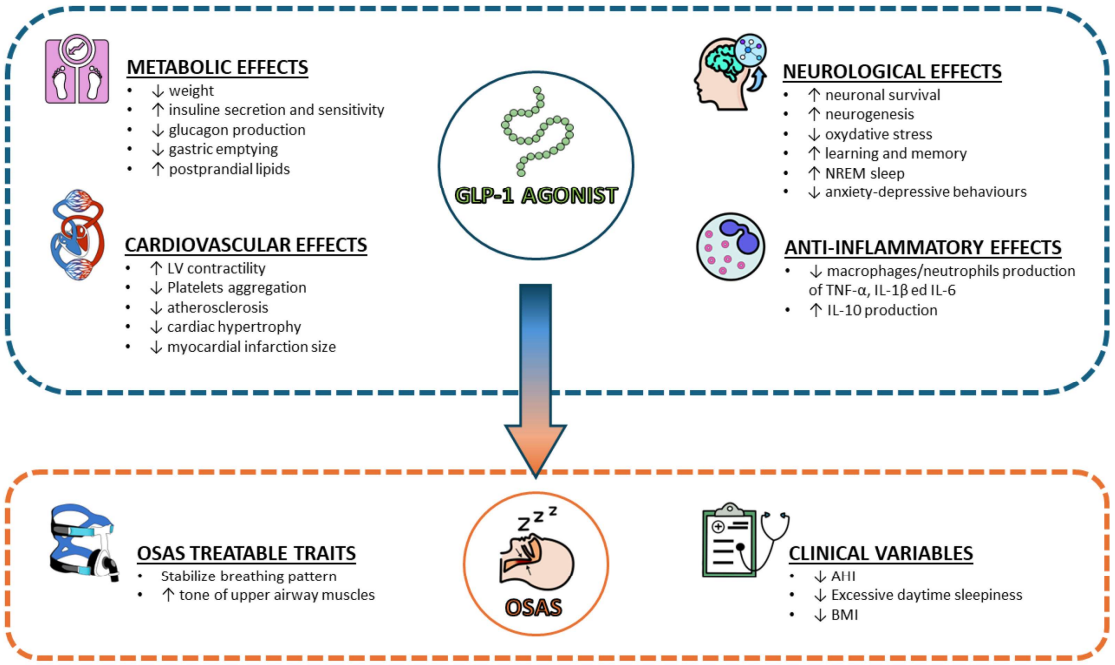
WILEY

Body composition changes during weight reduction with tirzepatide in the SURMOUNT-1 study of adults with obesity or overweight

Michelle Look MD[1] | Julia P. Dunn MD[2] | Robert F. Kushner MD[3] | Dachuang Cao PhD[2] | Charles Harris MD[2] | Theresa Hunter Gibble PhD[2] | Adam Stefanski MD[2] | Ryan Griffin Pharm. D.[2]

- Muscle Reduction (rapid weight loss)
  - SURMOUNT -1 clinical trial had significant reduction in muscle volume (~25%)
- Increased dose increases side effects related to compliance
  - GI side effects (nausea, diarrhea, vomitting)
  - Can decrease dose and even 5mg can result in 15% weight loss.
- Stopping treatment leads to regain of last weight
  - SURMOUNT-4 study; 36 weeks with drug and followed by 52 week wash out
  - 17% with placebo kept weight off compared to 90% that stayed on tirzepatide

Sleep Apnea Treatment Independent of Weight Loss



diseases MDPI

Review

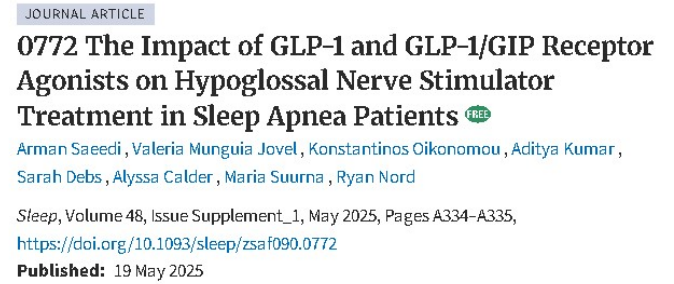
Therapeutic Potential of Glucagon-like Peptide-1 Receptor Agonists in Obstructive Sleep Apnea Syndrome Management: A Narrative Review

Silvano Dragonieri [1,*], Andrea Portacci [1], Vitaliano Nicola Quaranta [1], Pierluigi Carratu [2], Zsofia Lazar [3], Giovanna Elisiana Carpagnano [1] and Andras Bikov [4]

- Anti-Inflammatory Effect
  - GLP-1RA reduces proinflammatory TNF-α, IL-1β, and IL-6 AND increases anti-inflammatory IL-10
- Cardiovascular Risk
  - GLP-1 receptors regulate autonomic blood pressure
  - GLP-1RA reduction in vascular inflammation and atherosclerosis (decrease endpoint symptomology)
- Neurological Effects
  - GLP-1RA promotes neuronal survival, reduces oxidative stress, increases neurogenesis.

Combination Therapies

- GLP-1 receptor agonists alone are not sufficient as a sole treatment for OSA
- High dose required for clinically meaningful AHI reduction has a high frequency of adverse events including nonfatal strokes, psychiatric derangements, and myocardial infarctions
- GLP-1 RA takes months (~6mo) to reduce BMI that provides significant benefit from OSA
- “Bariatric surgery will be reduced with tirzepatide, but oral appliance treatment should not be affected.” – Rich Schwab



JOURNAL ARTICLE

0772 The Impact of GLP-1 and GLP-1/GIP Receptor Agonists on Hypoglossal Nerve Stimulator Treatment in Sleep Apnea Patients

Arman Saeedi, Valeria Munguia Jovel, Konstantinos Oikonomou, Aditya Kumar, Sarah Debs, Alyssa Calder, Maria Suurna, Ryan Nord

Sleep, Volume 48, Issue Supplement_1, May 2025, Pages A334–A335,
https://doi.org/10.1093/sleep/zsaf090.0772
Published: 19 May 2025

EXPERT OPINION ON PHARMACOTHERAPY
2025, VOL. 26, NO. 1, 51–62
https://doi.org/10.1080/14656566.2024.2437525

Taylor & Francis
Taylor & Francis Group

REVIEW

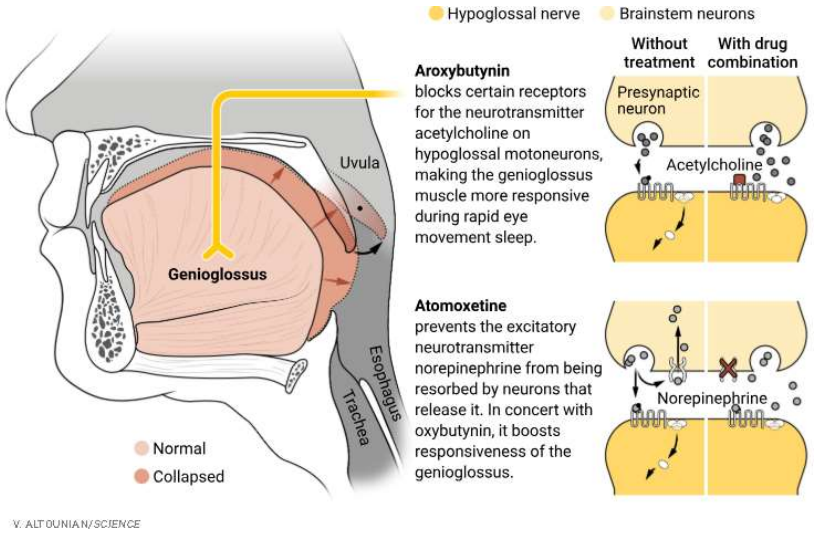
Current perspectives on the use of GLP-1 receptor agonists in obesity-related obstructive sleep apnea: a narrative review

Ali A. El-Solh[a,b,c], Erin Gould[b], Keziah Aibangbee[b], Tanya Jimerson[b] and Rebecca Hartling[b]

[a]Sleep Disorders Research Center, Western New York Healthcare System, Buffalo, NY, USA; [b]Division of Pulmonary, Critical Care, and Sleep Medicine, Department of Medicine, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, NY, USA; [c]Department of Epidemiology and Environmental Health, School of Public Health and Health Professions, Buffalo, NY, USA

Apnimed

- AD109 product for neuromuscular dysfunction associated with OSA. Combination of 2 drugs (atomoxetine and aroxybutynin)



Phase III trials LunAIRo (1yr) and SynAIRgy (6mo) meeting expectations and planned to be on market

Early data showing good clinical results; LunAIRo and SynAIRgy Phase III

Chugai Pharmaceutical

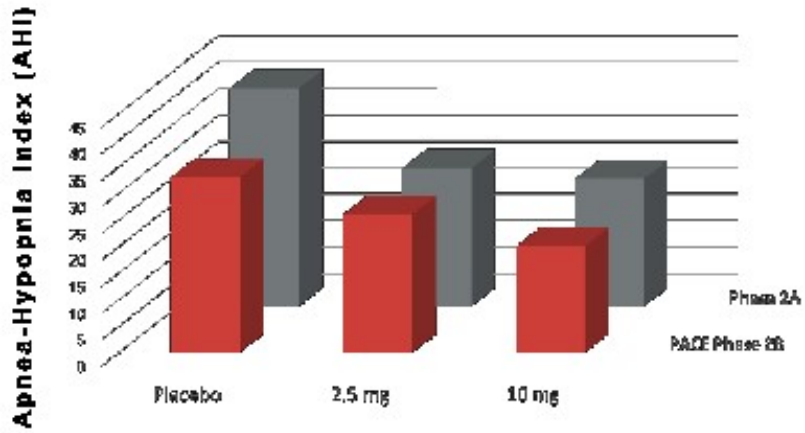
- Tofogliflozin (Sodium-glucose cotransporter-2) is approved for type 2 diabetes. Effect seen in OSA patients with HF and DM

Not approved for OSA. Indication is T2DM

6 mo administration reduced AHI by 18.3%

RespireRx Pharmaceuticals Inc.

- Developing oral capsule dronabinol (synthetic THC / D9-THC) to treat OSA. ResolutionRx. Also working on AMPAkines and GABAkinesfor pain and ADHD.



Not on the market.

Phase 2 product through 505(b)(2).PACE clinical trial reduced by 13 AHI.

Incannex

- Developing oral capsule IHL-42X (combination therapy of acetazolamide and dronabinol)

Not on the market.

Phase 2/3 efficacy and safety trial (RePOSA). 18 AHI reduction. In another, 43 to 21 AHI reduction with 80% reduction in severity.

In Context – Other Medications

Review articles

Pharmacological treatment for obstructive sleep apnea: A systematic review and meta-analysis

Maria Luísa Nobre[a], Ayane Cristine Alves Sarmento[a,b], Priscila Farias de Oliveira[c], Felipe Ferreira Wanderley[d], José Diniz Júnior[c], Ana Katherine Gonçalves[a,e,*]

[a] Programa de Pós-Graduação em Ciências da Saúde, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil
[b] Department of Clinical Analysis and Toxicology, Universidade Federal do Rio Grande do Norte, RN, Brazil
[c] Department of Surgery, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil
[d] Faculdade de Medicina, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil
[e] Department of Gynecology and Obstetrics, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil

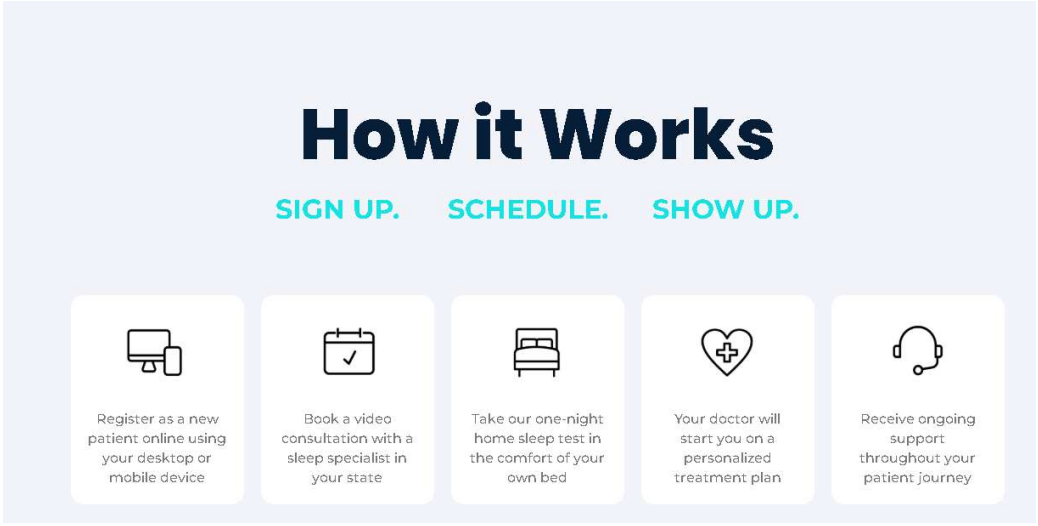
	Certainty assessment							№ of patients		Effect		Certainty	Importance
Comparison	№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	[Intervention]	[Placebo]	Relative (95% CI)	Absolute (95% CI)		
Nasal steroid vs Placebo	3	randomised trials	not serious	not serious	serious	not serious	none	46	46	-	MD **1.74 lower** (7.79 lower to 4.3 higher)	⊕⊕⊕◯ Moderate	IMPORTANT
Nasal decongestant vs Placebo	2	randomised trials	serious	not serious	serious	not serious	none	27	27	-	MD **7.97 events/h lower** (18.71 lower to 2.77 higher)	⊕⊕◯◯ Low	NOT IMPORTANT
AtoOxy vs Placebo	5	randomised trials	not serious	not serious	not serious	not serious	none	144	143	-	MD **7.71 lower** (10.59 lower to 4.83 lower)	⊕⊕⊕⊕ High	IMPORTANT
ReboxOxy vs Placebo	3	randomised trials	not serious	not serious	not serious	not serious	none	47	47	-	MD **10.78 events/h lower** (24.27 lower to 2.71 higher)	⊕⊕⊕⊕ High	IMPORTANT
Mirtazapine vs Placebo	3	randomised trials	serious	serious	not serious	not serious	none	79	79	-	MD **1.11 events/h lower** (11.88 lower to 9.66 higher)	⊕⊕◯◯ Low	IMPORTANT
Eszopiclone vs Placebo	3	randomised trials	not serious	not serious	not serious	not serious	none	77	79	-	MD **2.24 events/h lower** (6.14 lower to 1.67 higher)	⊕⊕⊕⊕ High	IMPORTANT
Sodium oxybate vs Placebo	2	randomised trials	serious	not serious	not serious	not serious	none	68	64	-	MD **5.5 events/h lower** (9.28 lower to 1.73 lower)	⊕⊕⊕◯ Moderate	IMPORTANT
Trazodone vs Placebo	2	randomised trials	not serious	not serious	serious	not serious	none	37	37	-	MD **12.75 events/h lower** (21.3 lower to 4.19 lower)	⊕⊕⊕◯ Moderate	IMPORTANT
Zolpidem vs Placebo	2	randomised trials	serious	not serious	serious	not serious	none	61	61	-	MD **0.21 events/h lower** (4.39 lower to 3.96 higher)	⊕⊕◯◯ Low	NOT IMPORTANT
Zopiclone vs Placebo	3	randomised trials	not serious	not serious	serious	not serious	none	54	56	-	MD **0.98 events/h lower** (9.71 lower to 7.76 higher)	⊕⊕⊕◯ Moderate	IMPORTANT
Donepezil vs Placebo	3	randomised trials	not serious	not serious	serious	not serious	none	63	63	-	MD **8.56 events/h lower** (15.78 lower to 1.33 lower)	⊕⊕⊕◯ Moderate	IMPORTANT

CI: confidence interval; **MD:** mean difference


Digital Health

Ognomy

- Digital health to streamline sleep apnea process. Corporate investor is Inspire Medical Systems. Uses AI.

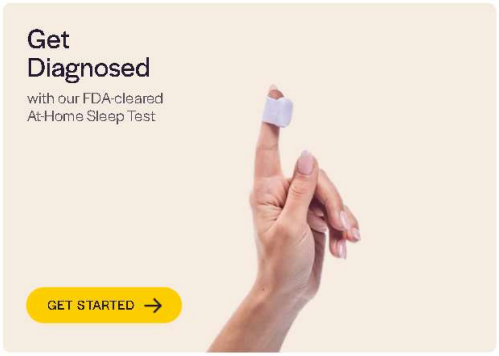


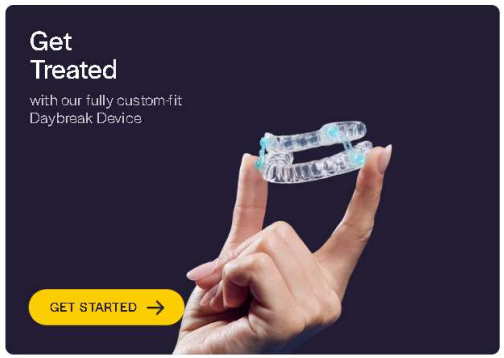
On market.

No studies

Daybreak

- Offers OTC oral appliance therapy through website in addition to OSA diagnostics.





On market.

No studies

EnsoData

- Current focus on diagnostics. Working with partners for hardware and has corporate investors of Inspire Medical Systems

On market.

No studies

Oral Appliance Therapy

Somnomed

- Smart oral appliance that detects efficacy and compliance. Announced Feb 2022

Not on market in US.

High agreement in total sleep (r = .8) yet issues with supine sleep (64% correlation)

Vivos

- Vibration on lingual of teeth from the oral device to treat sleep apnea.
- Intermittent light cyclical forces to stimulate craniofacial osteogenesis

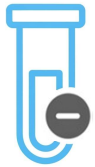
Vibration device not on market

No studies regarding this product.

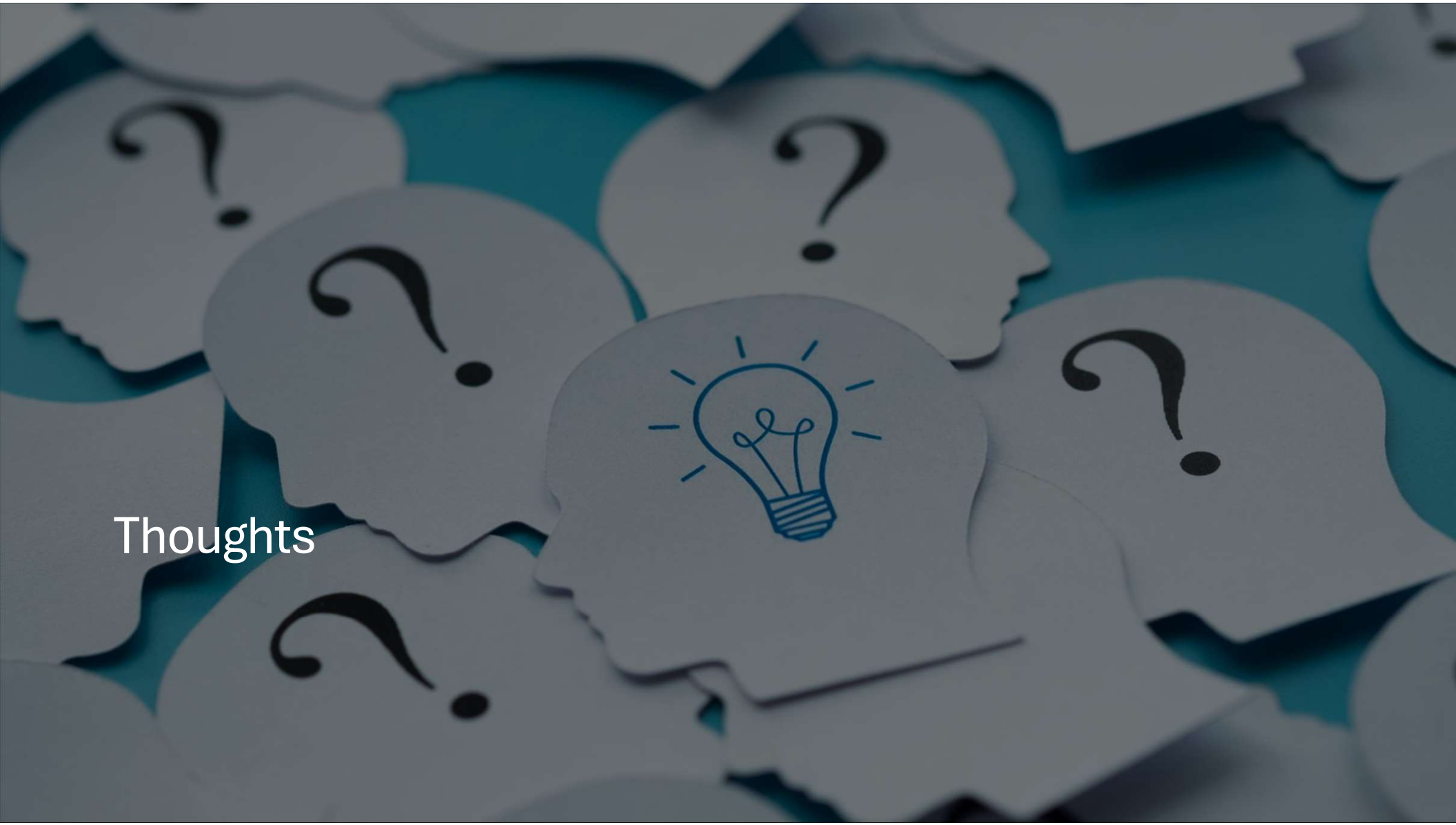
Prosomnus

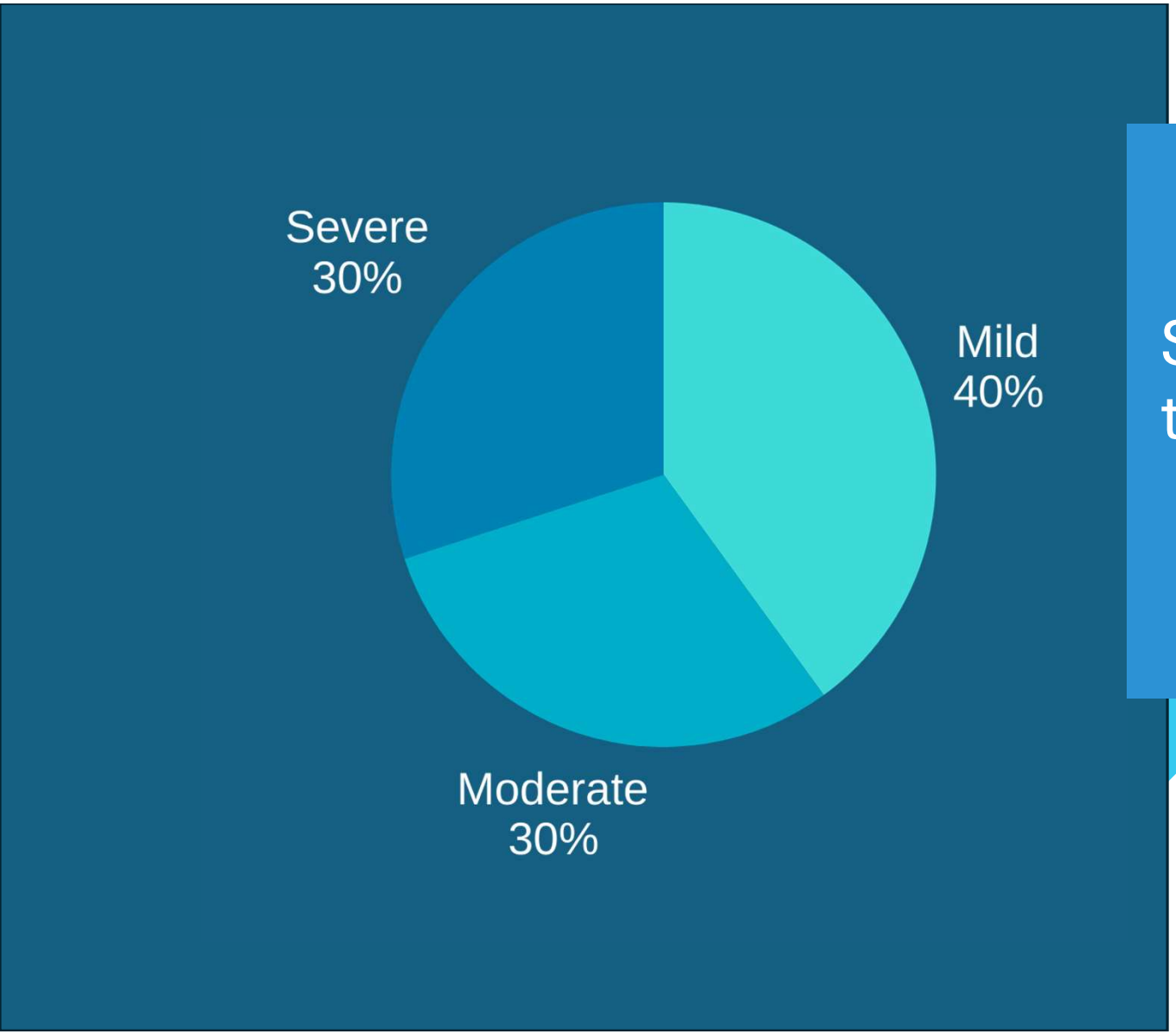
- Remote patient monitoring RPMO2 OSA Device. Showed similarity to pulse oximeter per company. 12 patients enrolled.

Not on the market yet.
Applied to FDA.



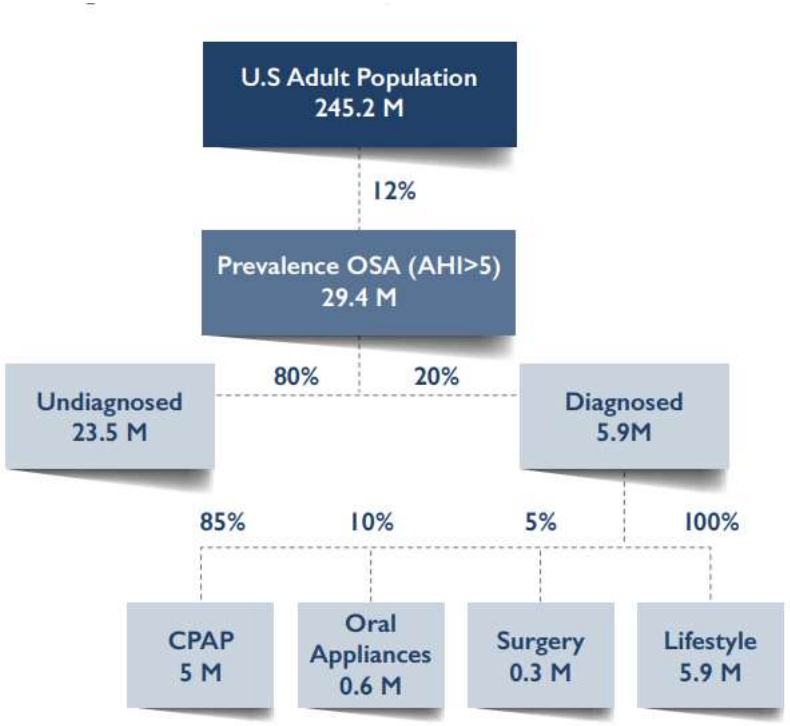
Accuracy root mean square of 2.32%


Thoughts

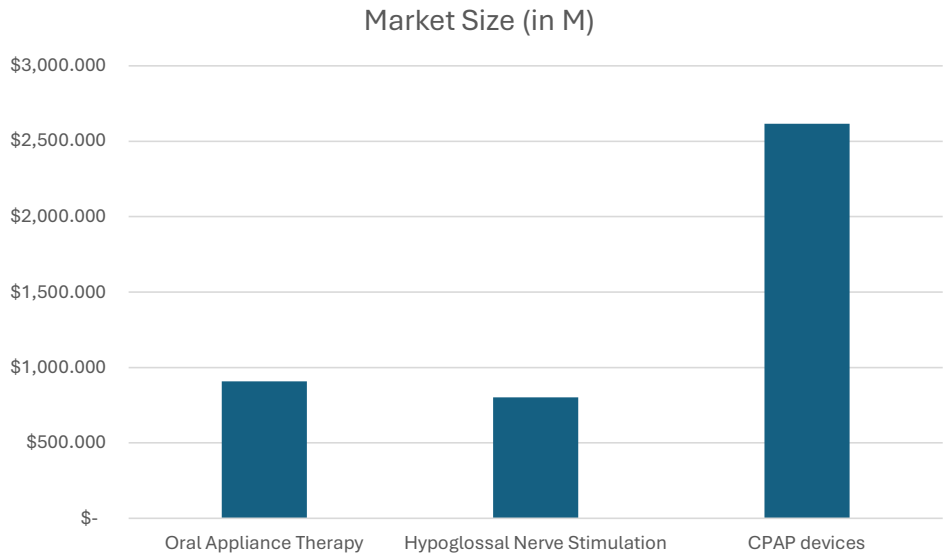


Severity of Disease in the Population

Clinical and Financial Positions



Frost & Sullivan 2016 report



Estimates for 2025

Dentists' Role

Dentist

Mandibular Advancement Devices
- Somnomed
- Prosomnus
- Vivos

DME / Consumer

Positional Sleep Apnea
- Smart Nora
- Night Balance

Digital Health
- Ensodata
- Ognomy
- Daybreak

Myofunctional Therapy Devices
- ExciteOSA
- REMastered Sleep

Non-Dentist

Pressure Systems
- KPAP
- Sommetrics

Surgical Hypoglossal Nerve Stimulation
- Inspire
- Nyxoah
- Liva Nova
- StimAire

Soft Palate Augmentations
- Cryosa

Pharmacology
- Eli Lilly
- Apnimed
- Chugai Pharm
- RespireRX Pharm
- Incannex

Hyoid Suspension
- MagNap
- Siesta Medical

Tongue Mobility
- Respiosa
- Linguaflex

Non-Invasive Neuromodulation
- XII Medical
- Pasithea
- Restera
- WhisperSom

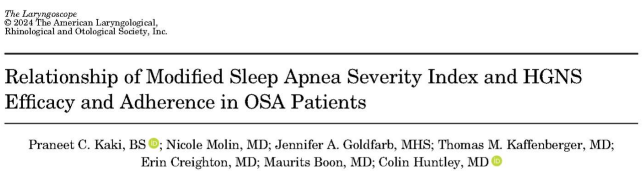
Compliance

- **CPAP**: after 1 year 50% non-compliant
- **Inspire**: after 30 days 7%; after 6 months 7-25% non-compliant
- **Tirzepatide**: after 1 year 50% non-compliant

Research Letter | Diabetes and Endocrinology

GLP-1 Receptor Agonist Discontinuation Among Patients With Obesity and/or Type 2 Diabetes

Duy Do, PhD; Tiffany Lee, PhD; Samuel K. Peasah, PhD, RPh, MBA; Chester B. Good, MD, MPH; Angela Inneh, MPH, MBA; Urvashi Patel, PhD, MPH


The Laryngoscope

Relationship of Modified Sleep Apnea Severity Index and HGNS Efficacy and Adherence in OSA Patients

Praneet C. Kaki, BS; Nicole Molin, MD; Jennifer A. Goldfarb, MHS; Thomas M. Kaffenberger, MD; Erin Creighton, MD; Maurits Boon, MD; Colin Huntley, MD