Title: A novel hypoglossal nerve stimulation approach restores upper airway function and airflow to therapeutic CPAP levels in people with obstructive sleep apnea

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RATIONALE: Hypoglossal nerve stimulation (HGNS) provides efficacious therapy with high compliance for many people with obstructive sleep apnea (OSA). However, efficacy with HGNS varies between patients and is difficult to predict. Currently approved HGNS approaches are also quite invasive and costly. Accordingly, this proof-of-concept study was designed to determine the feasibility for a new multi-stimulation sensor less invasive delivery approach to target the hypoglossal nerve to improve upper airway function and airflow responses.

METHODS: Participants with OSA were instrumented with an electroencephalogram, electrooculogram, submental chin electromyogram, an epiglottic pressure and a sealed nasal mask and pneumotach to quantify airflow. Following propofol sedation, the hypoglossal nerve was identified using ultrasound to guide percutaneous electrode array placement for HGNS. An endoscope was inserted via the nose to visualise changes to airway size and shape with HGNS. A modified CPAP device was used to deliver therapeutic CPAP and transient pressure reductions to induce airflow limitation/closure and quantify passive pharyngeal critical closing pressure (Pcrit). A range of HGNS amplitudes and electrode array combinations were tested during an ~1.5h protocol to determine the optimal site and response to HGNS. CPAP reductions for at least 9 breaths were delivered, with HGNS applied during breaths 4-6. In addition, active Pcrit with and without stimulation was measured when time permitted.

RESULTS: To date, 14 predominantly obese people (BMI= 30±3Kg/m^2) with severe OSA (AHI=30±16events/h sleep) have been studied. 13/14 participants had a quantifiable increase in airflow at the optimal stimulation setting and location. On average, there were 10±5 CPAP reductions with HGNS applied per participant and airflow increases occurred in an average of 8±4 trails per participant during the 1.3±0.2h protocol. Average peak inspiratory flow (PIF) on therapeutic CPAP was 0.38±0.1 L/s^{-1}. With transient CPAP reductions PIF was reduced to 0.12±0.07 L/s^{-1} for breaths 1-3 ($p<0.01$ vs. therapeutic CPAP) and increased to therapeutic

CPAP levels with HGNS (0.43±0.17L/s^{-1}, p=0.38 vs. therapeutic CPAP). Similarly, minute ventilation reduced from therapeutic to sub-therapeutic CPAP (4.8±2.0 vs. 2.2±1.7L/min, p<0.05) and returned to therapeutic CPAP levels with HGNS (5.9±2.2L/min p=0.19 vs. therapeutic CPAP). Average passive Pcrit was 1.4±2.4cmH_2O (n=12) and active Pcrit without HGNS was -1.0±3.2cmH_2O (n=8). With HGNS, Active Pcrit markedly improved (-7.2±1.6cmH_2O, p<0.01, n=4).

CONCLUSIONS: Acutely targeting the hypoglossal nerve using a novel, less-invasive, ultra-sound guided, multi-stimulation sensor array in people with severe OSA markedly improves airflow equivalent to therapeutic CPAP levels and reduces upper airway collapsibility by ~7cmH_2O during propofol sedation.

Summary data FYI only- not to be included in the abstract