# A Modified Definition for Obstructive Sleep Apnea in Home Sleep Apnea Testing after Stroke or Transient Ischemic Attack

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*Background:* Home sleep apnea testing (HSAT) underestimates obstructive sleep apnea (OSA) severity. Overnight oxygen desaturation has been shown to be a strong predictor of incident stroke, and may be helpful in determining which patients with lower apnea-hypopnea indices (AHIs) should be offered treatment. *Objectives:* To examine whether a modified definition for OSA that uses oxygen desaturation (i.e., AHI 5-14.9 per hour and lowest $O_2$ desaturation ≤88%), as compared to an AHI ≥ 15 per hour, would impact: (1) changes in Epworth Sleepiness Scale scores post-continuous positive airway pressure (CPAP) initiation; (2) CPAP compliance rates; and (3) the accuracy of automated versus manual scoring of HSAT. *Methods:* One hundred and six patients with a prior stroke or transient ischemic attack (TIA) underwent HSAT. Epworth Sleepiness Scale and CPAP compliance were measured at baseline and 3-6 months. *Results:* Median age was 67.5 years, 57.5% male, and 76.4% presented with stroke. Fifty-nine patients were diagnosed with OSA; of these 54.2% met criteria for the "modified definition" for OSA (AHI 5-14.9 per hour with oxygen desaturation) and 45.8% met criteria for the "classic definition" for OSA (AHI ≥15). The modified (versus classic) definition had: (1) a greater decrease in ESS ($P = .05$) post-CPAP initiation; (2) comparable CPAP compliance rates; and (3) comparable automatically versus manually scored AHIs (Spearman's rho = .96, Cohen's Kappa ≥ .75 for both definitions, $P < .001$). *Conclusions:* Using a modified definition of OSA that uses a lower AHI cutoff and includes an oxygen desaturation cutoff in the setting of HSAT for stroke or transient ischemic attack (TIA) patients may improve daytime sleepiness post-CPAP initiation, while not significantly affecting CPAP compliance rates nor the accuracy of automated scoring. **Key Words:** Home sleep apnea testing—obstructive sleep apnea—stroke—transient ischemic attack—definitions.


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## Introduction

Obstructive sleep apnea (OSA) is an independent risk factor for stroke and death[1] and is found in 50%-70% of patients with cerebrovascular events.[2] Mounting evidence indicates that untreated OSA in stroke or transient ischemic attack (TIA) survivors is associated with longer hospitalizations,[3] poor functional outcomes,[4] increased risk of further strokes,[5] and mortality.[6] Treating OSA with continuous positive airway pressure (CPAP) improves post-stroke functional and motor outcomes.[7]

The gold standard for diagnosing sleep apnea is in-laboratory polysomnography (PSG); however, many stroke or TIA patients find PSG cumbersome. In addition, PSG is costly and labor-intensive. Recently, there has been increasing interest in the use of home sleep apnea testing (HSAT). These portable devices provide a simple, more convenient,[8] and potentially cost-effective alternative to PSG. However, in contrast to PSG, level III HSAT devices do not record electroencephalography and electromyography and, therefore, cannot accurately differentiate between wake and sleep. Due to this limitation, the total sleep time taken into account by HSAT may be erroneously inflated and, consequently, the severity of OSA underestimated.[9-11] To counterbalance this issue, treating patients with lower apnea-hypopnea indices (AHI) may be prudent.

Furthermore, while the AHI has been the traditional parameter for defining OSA, recent work suggests that the overnight oxygen desaturation is a stronger predictor of incident stroke in the elderly.[12] Recognizing the clinical significance of overnight oxygen desaturation, as well as the potential for HSAT to underestimate OSA severity, Boulos et al 2016[13] proposed a modified definition for OSA in patients with stroke or TIA. According to this definition, OSA is defined as an AHI ≥15 regardless of the degree of oxygen desaturation, or 5 ≤ AHI ≤14.9 with the lowest oxygen saturation ≤88% for ≥10 seconds. The cutoff for oxygen desaturation was proposed based on the characteristic drop in partial pressure of oxygen ($PO_2$) that occurs on the sigmoidal oxygen-hemoglobin dissociation curve at 88% oxygen saturation. Any further decrease in saturation results in a sharp decrease in $PO_2$, leading to significant hypoxemia.[13,14]

In the randomized controlled trials that have investigated the effect of CPAP after stroke or TIA, the definition for OSA has varied[7,15-23] (see Table 1). With use of HSAT in patients presenting with cerebrovascular events, there may be clinical benefits to using a modified definition for OSA that uses a lower AHI cutoff and includes an oxygen desaturation cutoff.

The objective of the present study was to examine whether a modified definition for OSA that included the degree of nocturnal oxygen desaturation and a lower AHI cutoff would impact: (1) changes in daytime sleepiness as measured by the Epworth Sleepiness Scale (ESS) score after CPAP initiation; (2) change in neurological status, cognition and depressive symptoms; (3) rates of CPAP compliance; (4) percent of normalization on CPAP to an AHI of ≤5 per hour; and (5) the accuracy of automated scoring of an HSAT device compared to manual scoring by a registered sleep technologist.

## Materials and Methods

### *Study Subjects*

All patients provided written informed consent before participating in a feasibility study[8] or the HSAT arm of a randomized controlled trial.[24] During July 2014 to Feb-

**Table 1.** *Definitions of OSA utilized in RCTs examining the effect of CPAP in the stroke/TIA population (ordered by year)*

| Study (y) | N | Tool used to detect OSA | Definition for OSA |
|---|---|---|---|
| Sandberg et al (2001)[15] | 63 | Micro Digitrapper SAS; Synectics AB, Stockholm, Sweden | AHI ≥ 15 |
| Hsu et al (2006)[16] | 30 | Embletta Portable Diagnostic System, Medcare Flaga, Iceland | AHI ≥ 30 |
| Parra et al (2011)[17] | 126 | Hypno TT Digital Recorder; Tyco/Healthcare/Puritan Bennett, Villers-lès-Nancy, France) | AHI ≥ 20 |
| Ryan et al (2011)[7] | 44 | Polysomnography | AHI ≥ 15 |
| Bravata et al (2011)[18] | 55 | Portable unattended polysomnography (LifeShirt, Vivometrics, Ventura, CA) for control group and auto-CPAP machine (AutoSet Spirit, ResMed, Poway, CA) for the intervention group | AHI ≥ 5 |
| Minnerup et al (2012)[19] | 50 | Portable cardiorespiratory recording device (Somnoscreen; Somnomedics) | AHI ≥ 10 |
| Barbé et al (2012)[20] | 723 | Conventional polysomnographic or cardiorespiratory sleep study | AHI ≥ 20 |
| Brown et al (2013)[21] | 32 | Polysomnography or portable respiratory monitor, the ApneaLink (Resmed, Inc) | AHI ≥ 5 |
| McEvoy et al (2016)[22] | 2717 | Home sleep-study screening device (ApneaLink, ResMed) | AHI ≥ 30 |
| Peker et al (2016)[23] | 244 | ResMed S8 (Auto-CPAP) | AHI ≥ 15 |

Abbreviations: AHI, apnea-hypopnea index; CPAP, continuous positive airway pressure; OSA, obstructive sleep apnea; RCT, randomized controlled trials; TIA, transient ischemic attack.