



Novel and modifiable factors associated with adherence to continuous positive airway pressure therapy initiated during stroke rehabilitation: An exploratory analysis of a prospective cohort study

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ABSTRACT

Objective/Background: Continuous positive airway pressure (CPAP) for the treatment of sleep apnea may improve stroke recovery but is limited by poor adherence. We evaluated baseline features and psychosocial factors associated with CPAP adherence among stroke patients enrolled in a pilot study of an intensive CPAP adherence protocol initiated during inpatient rehabilitation.

Patients/Methods: In a retrospective analysis of a prospective cohort study, we compared participants adherent to CPAP (≥ 4 h for $\geq 70\%$ of nights over 3 months) to non-adherent participants. Using mixed methods, we quantitatively compared baseline demographic and stroke-related factors associated with adherence and qualitatively compared facilitators and barriers to adherence.

Results: There were 32 adherent and 20 non-adherent participants. Quantitative analysis revealed more severe stroke, aphasia and white race were associated with adherence. Adherent compared to non-adherent participants also had fewer early CPAP complaints, especially claustrophobia. In a thematic qualitative analysis, facilitators of adherence included improvement in sleep and stroke symptoms, confidence in CPAP use, and positive treatment expectations. Conversely, barriers to adherence included both potentially modifiable factors (lack of confidence in CPAP use, discomfort with a new health technology, and common CPAP-related complaints), and less modifiable factors (social stressors, sleep disturbance, and lack of home social support).

Discussion: Adherence programs for CPAP use after stroke should address modifiable barriers, with early desensitization to improve CPAP-related complaints and claustrophobia, and training to address perceived self-efficacy with CPAP. Future studies should explore individual goals and barriers associated with CPAP use among stroke survivors to improve long-term CPAP adherence.

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1. Introduction

Stroke is the leading cause of adult-onset disability in the United States. Obstructive sleep apnea (OSA) affects about 70% of adults after stroke [1] and is associated with poor post-stroke outcomes [2–4]. Treatment with continuous positive airway pressure (CPAP)

Abbreviations: IPR, Inpatient rehabilitation; MI, Motivational interviewing.

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is associated with better stroke recovery [5–8] though estimates of CPAP adherence range between 12 and 25% when initiated soon after a stroke [9]. Stroke patients with OSA likely have different barriers to CPAP use and the psychosocial variables associated with adherence in the general population, including self-efficacy, treatment beliefs or social support, likely differ after stroke. To investigate factors associated with CPAP adherence at 3 months in stroke patients, we performed an exploratory, mixed methods analysis of a single-arm, prospective cohort study of an intensive CPAP adherence protocol initiated during inpatient rehabilitation (IPR).

2. Methods

2.1. Study participants and intervention

The parent single-arm study included 90 adult participants with an acute ischemic stroke or intracerebral hemorrhage who were admitted to an IPR unit between 2016 and 2019, as detailed elsewhere [7]. A presumptive diagnosis of OSA was made during a 3-night run-in period in participants where flow limitation was detected by the auto-adjusting CPAP (4–20 cm H₂O; Dream Station, Philips Respironics) and as used in other studies to select patients with cerebrovascular disease for CPAP treatment [6,10]. Qualifying participants underwent an intensive adherence intervention consisting of iterative CPAP adjustments by respiratory therapists and sleep technologists, motivational interviewing (MI) by a clinical psychologist, and weekly outpatient phone calls by study personnel [7]. This study was approved by the University of Washington Human Subjects Review Committee.

The current analysis includes the subgroup of initial study participants from the parent study who met criteria for OSA, did not have evidence of central sleep apnea (CSA), and chose to continue CPAP treatment after discharge from IPR (n = 52). Adherent participants included those participants who used CPAP after IPR discharge for ≥4 h per night on ≥ 70% of nights over the 3-month treatment period (n = 32). (Figure 1).

2.2. Data collection

During the 3-night CPAP run-in period, all participants completed a 7-question form screening for common complaints associated with CPAP use (mouth dryness, nasal symptoms, eye problems, claustrophobia, noise problems, facial soreness or skin irritation, and mask fit or leak problems) to guide optimization of CPAP settings and mask fit [11]. During the IPR stay, clinical psychologists led 30-min MI sessions with each participant and completed checklists to systematically assess reasons for using CPAP (e.g., stroke recovery, stroke prevention) and for not using CPAP (e.g., claustrophobia, anxiety, sleep disturbance, mask intolerance or device problems). At the end of the 3-month treatment period, participants were interviewed by study personnel to further assess facilitators and barriers to CPAP use.

2.3. Statistical analysis

2.3.1. Quantitative analysis

Multivariable logistic regression was used to test the association between baseline characteristics and adherence. Variables included in the model were age, self-reported race/ethnicity (white vs. non-white), sex, body mass index (BMI), baseline National Institutes of Health Stroke Scale (NIHSS; range, 0 to 42; higher scores indicate greater neurologic impairment and stroke severity), presence of aphasia, and IPR length of stay. To determine the association of CPAP adherence with complaints during the 3-night run-in, we compared adherent vs. non-adherent participants for the overall number of individual complaints (Mann-Whitney U test) and for each of the 7 CPAP complaints (Chi-square test).

2.3.2. Qualitative analysis

Five investigators (SPK, HMB, APD, EB, MMG) conducted a thematic qualitative analysis of the MI notes by the psychologist and the notes from the end-of-study interviews at 3 months. Each investigator coded potentially modifiable and less-modifiable psychosocial, cognitive, and behavioral facilitators and barriers for CPAP use. Investigators identified themes by reading notes and

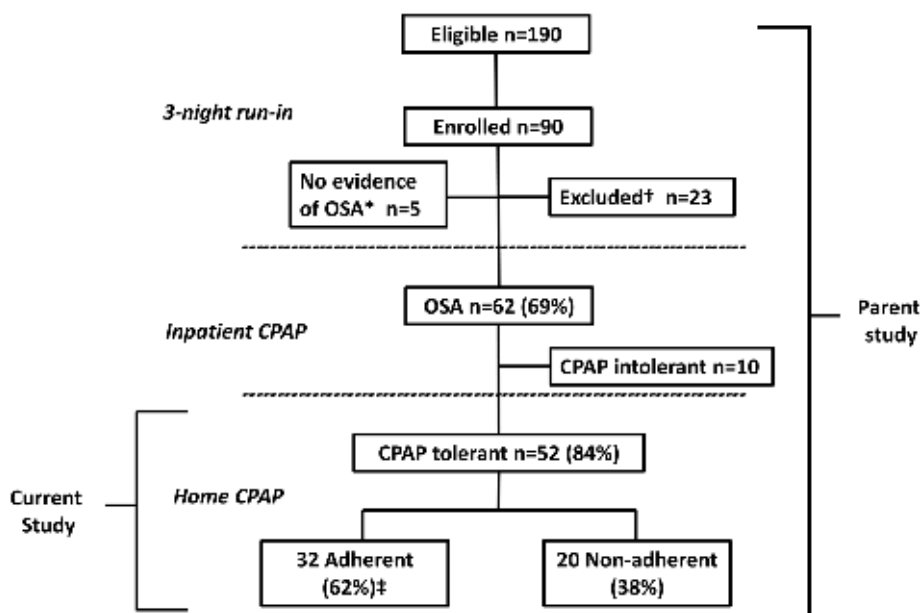


Fig 1. Flow of study participants through the study.

coding themes as facilitators and barriers to CPAP adherence. Consensus was then achieved in defining a core set of themes observed and categorizing these themes as modifiable or less-modifiable facilitators or barriers of CPAP use.

3. Results

Among the 52 participants included in the current analysis, the mean age was 59 ± 10.8 years, 32 (61.5%) were men, and the mean BMI was 30.4 ± 6.8 kg/m². Stroke types included 35 (67.3%) ischemic stroke and 17 (32.7%) intracerebral hemorrhage. The median length of stay on IPR was 16.5 days (interquartile range 9.8, 21.3) and 15 participants (28.8%) exhibited at least mild aphasia. Mean nightly CPAP use over the 3-month period was 4.7 (standard deviation 2.6) hours, and 32 participants (62%) achieved the primary outcome of CPAP adherence.

In the multivariable model, factors significantly associated with CPAP adherence included the presence of aphasia (*p* < 0.01), increased stroke severity with NIHSS ≥ 5 (*p* = 0.02), and white race (*p* < 0.01), as reported previously [7]. Fourteen of the 15 participants with aphasia (93%) were adherent over 3 months compared to 18 of 37 (49%) of the non-aphasic participants (relative risk: 1.92; 95% confidence interval [CI] 1.34–2.74). After adjustment for age, sex, race, and BMI, participants with aphasia demonstrated greater average use per night (6.4 ± 1.8 h versus 4.0 ± 2.6 h; *p* = 0.02) compared to non-aphasic participants.

The most common CPAP complaints noted during the run-in period were claustrophobia (23%), mouth dryness (39%), nasal symptoms (44%), and mask fit or leak problems (52%). Compared to non-adherent participants (*n* = 20), adherent participants experienced fewer total CPAP complaints during the 3-night run-in period (2.8 vs. 4.3, *p* = 0.003). Of the 7 complaints, only claustrophobia was significantly more common among non-adherent than adherent participants (40% vs. 13%, *p* = 0.02).

The qualitative thematic analysis of MI and 3-month-interview notes revealed numerous modifiable facilitators of CPAP use, including confidence using CPAP and positive expectations of the treatment’s benefit (Table 1). Less-modifiable facilitators of adherence were also noted, including home social support and improvements in sleep or stroke-related symptoms. Modifiable

barriers included discomfort using a new health technology, common CPAP complaints including anxiety, and perceived lack of CPAP-related skills, including donning the mask. Participants also described less modifiable and more complex barriers such as social stressors, sleep disturbance, and a lack of social support.

4. Discussion

Intervention targets to increase CPAP use after stroke likely differ from the general OSA population. Stroke patients have few if any OSA-related symptoms [12] and are thus unlikely to be motivated by immediate symptomatic benefit. In the initial aftermath of stroke, however, the possibility of optimizing neurologic and functional recovery and reducing risk of stroke recurrence may be relevant motivators. The multi-faceted adherence intervention may have contributed to the success in achieving good adherence even among participants with more severe stroke and aphasia. The increased adherence in aphasic participants, who are often excluded from CPAP studies after stroke, may also be related to a perceived benefit of CPAP in communication and social interaction, potentially leading to greater motivation to adhere to therapy.

A significantly higher number of early CPAP complaints was noted during early CPAP adjustments among non-adherent participants, as has been previously described in patients with vascular disease [11]. The qualitative analysis in this study also revealed numerous previously undescribed barriers and facilitators of CPAP use. A prior study in this population employing qualitative methods to explore challenges and motivators to CPAP use prior to initiating therapy and after one month also noted that “anticipated benefits” of reducing stroke risk and improvements in sleep or stroke symptoms were powerful facilitators of CPAP use. The current study, which utilized a standardized protocol for MI sessions during IPR and assessed perceptions after a longer 3-month treatment period, identified additional psychosocial, cognitive, and behavioral barriers. Future post-stroke CPAP adherence programs should focus on early desensitization to CPAP masks and other interfaces to mitigate anxiety and claustrophobia. Treatment should also include enhanced “hands-on” training in how to use CPAP devices to enhance skills and confidence with this technology and to reduce discomfort. The MI counseling may enhance the effects of

Table 1
Common modifiable and less modifiable facilitators and barriers to CPAP adherence.

Facilitators and barriers to CPAP adherence	Modifiable (M) or less modifiable (LM)	Examples from Motivational Interviewing and 3-month notes
FACILITATORS		
CPAP self-efficacy	M	<i>Patient has been using the CPAP nightly for a week, is proud of putting the mask on with one hand and plans on continuing it following discharge.</i>
Outcome expectations	M	<i>Patient knows blood pressure can increase during sleep and that CPAP can treat the hypertension associated with sleep apnea and stroke.</i>
Sleep improvement	LM	<i>Patient has noted improvement in sleep quality and feeling rested upon awakening since using the CPAP. Patient is eager to maintain these gains.</i>
Stroke-related symptom improvement	LM	<i>Patient focused on the effects sleep apnea has on daily fatigue and believes if breathing improves at night, she will get her strength back.</i>
Home social support	LM	<i>Factors that boosted patient's confidence included having a supportive partner.</i>
BARRIERS		
CPAP-related skills (e.g., mask placement or device maintenance)	M	<i>Patient reports being motivated by her husband wanting her to wear it but does not yet know how to put it on by herself.</i>
Common CPAP-related complaints and anxiety	M	<i>Patient reported having a runny nose and that is why she had the CPAP removed the last time.</i>
Discomfort with a new health technology	M	<i>Patient is concerned about taking care of the device when getting home, particularly cleaning it.</i>
Sleep disturbance	LM	<i>Patient is concerned about the CPAP defeating its purpose by keeping him awake at night.</i>
Social stressors	LM	<i>Patient is facing multiple stressors when she gets home like unpaid bills and potential eviction.</i>
Lack of home social support	LM	<i>Patient describes himself as motivated to continuing using CPAP upon discharge though is not sure others will be there to support him if he needs it.</i>

standardized adherence training in future intervention trials by identifying and addressing patient-specific barriers and facilitators of CPAP use, including sleep disturbance, social stressors and lack of home social support. Adherence to CPAP was also lower among non-white participants, in accord with prior evidence where race has predicted lower adherence despite attempts to standardize access and treatment [13].

The limitations of our study include: the lack of a control group, which does not allow causal inference; the exclusion of initially CPAP-intolerant participants, reducing the generalizability to all stroke patients with OSA; the application of an innovative selection procedure for CPAP rather than formal polysomnographic testing, and the use of interview notes rather than recordings of the MI sessions. In this study, we also chose to focus on CPAP adherence for the treatment of OSA and opted to exclude participants with CSA, which tends to improve over time after stroke [14], is uncommon in this setting[1], is not associated with increased post-stroke mortality[2], and may require other treatments other than auto-adjusting CPAP [15]. Nevertheless, this study provides new actionable information on which to build more effective interventions to facilitate adherence to CPAP for stroke survivors with OSA. By focusing on the unique psychosocial, cognitive, and behavioral factors related to CPAP use after stroke, future investigators can discover ways to maximize the potential of CPAP to improve stroke recovery and prevention.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2022.05.013>.

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