Brief Report

Diagnostic Accuracy of Positive Airway Pressure Device for Sleep Apnea Detection in Acute Stroke Patients

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Background and Purpose—Sleep apnea has been associated with a poor outcome in acute stroke patients. Polysomnography is the gold standard diagnostic method for sleep apnea, but it is not feasible as a routine in the acute stroke setting. The current generation of positive airway pressure (PAP) devices can detect the different types of respiratory events. This study aimed to compare the algorithms used in PAP device to manually scored events on polysomnography in patients with acute stroke.

Methods—A sleep study was performed with standard polysomnography and PAP device, simultaneously, within the first 48 hours after acute stroke onset.

Results—We prospectively evaluated 29 patients with acute stroke (59.5±12.1 years). The area under the receiver operating characteristic curve for each apnea-hypopnea index value was above 0.90 by PAP device. There was a good correlation of apnea-hypopnea index (r_s=0.92; P<0.001), hypopnea index (r_s=0.89; P<0.001), and apnea index (r_s=0.70; P<0.001) between device-detected events and manually scored polysomnography.

Conclusions—Given the high frequency of sleep apnea during the acute phase of stroke and the complexity of a full polysomnography study in this setting, PAP device on diagnostic mode can be used as an alternative tool for sleep apnea detection in acute stroke patients. **(*Stroke*. 2020;51:00-00. DOI: 10.1161/STROKEAHA.119.027141.)**

Key Words: apnea ■ continuous positive airway pressure ■ polysomnography ■ sleep ■ stroke

Sleep apnea (SA) affects more than two-thirds of acute stroke patients, and it is associated with increased mortality and functional disability.[1–4] Consequently, the American Heart Association/American Stroke Association Guideline added the recommendation for screening SA in patients with ischemic stroke or transient ischemic stroke (Class IIb, Level of Evidence B).[5]

Polysomnography is the gold standard diagnostic method for SA. Unfortunately, due to several factors it is not feasible as a routine for all acute stroke patients. The current generation of positive airway pressure (PAP) devices innovates by the possibility of detecting the different types of respiratory events. However, PAP devices with automatic detection of sleep respiratory events have never been adequately compared with polysomnography in acute stroke setting. The aim of this study was to compare the algorithms used in a PAP device to manually scored events on polysomnography in patients with acute stroke.

Methods

The data that support the findings of this study are available from the corresponding author on reasonable request.

Consecutive patients admitted with a confirmed diagnosis of stroke by neuroimaging within 48 hours of symptoms' onset were assessed. The local Institutional Review Board approved this study and either the patient or their legal representative has signed a written informed consent.

The presence of SA was assessed by standard polysomnography (Sommeil S80 Meditron; Sao Paulo, BR) and by PAP device on diagnostic mode (System One REMstar Auto A-Flex, Philips-Respironics), simultaneously. All patients used an oronasal mask during the polysomnography. Exclusion criteria and sleep study measurements are provided in the online-only Data Supplement.

Statistical Analysis

The receiver operating characteristic curve, C statistics, Spearman correlation coefficient (r_s), intraclass correlation coefficient, and Bland-Altman plot were analyzed. Detailed statistical analysis is available in the online-only Data Supplement.

Results

Twenty-nine patients were enrolled: mean age was 59.5±12.1 years and 58.6% were males. None of them were assessed for SA before stroke. Baseline characteristics are summarized in Table in the online-only Data Supplement.

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The mean apnea-hypopnea index (AHI) was 28.8±29.7 events/h on manually scored polysomnography and 17.5±16.5 by PAP device (P=0.002). The mean hypopnea index (HI) was higher by manual scoring then by the device (20.9±18.4 versus 9.8±7.5; P<0.001). Conversely, the mean respiratory effort related arousal index (RERAI) was slightly higher by PAP device than polysomnography (3.1±3.5 versus 1.3±3.2; P=0.003). No significant difference was observed in the mean apnea index among those diagnostic methods, as shown in Table 1.

SA (AHI≥5) was diagnosed by polysomnography in 24 (83%) patients and severe SA (AHI≥30) in 11 (38%). Considering the PAP device, 21 (72%) patients had an AHI≥5 and 7 (24%) an AHI ≥30. The obstructive events were predominant, and no significant difference was found in obstructive apnea index between manually scored polysomnography and PAP device. All patients used PAP device for longer than 4 hours and none of them had any severe adverse event related to the exams.

The area under the receiver operating characteristic curve for predicting SA by PAP device was above 0.90 for each AHI value. Using the threshold of ≥10 events/h on the device, the specificity and positive predictive value were 1.0 for AHI≥10 events/h on polysomnography. For severe SA (AHI≥30/h), the values were 0.94 and 0.86, respectively. The cutoff levels of PAP device that would provide the optimal prediction of the respective threshold value of AHI by polysomnography were also shown in Table 2.

There was a good correlation of AHI (r_s=0.92; P<0.001), apnea index (r_s=0.70; P<0.001), and HI (r_s=0.89; P<0.001) between device-detected and manually scored polysomnography. The intraclass correlation coefficient was 0.64 (P<0.001), 0.65 (P<0.001), and 0.49 (P<0.001), respectively. No correlation of RERAI was found (P=0.40). According to the Bland-Altman plot, the mean AHI difference was −11.3±18.3 events/h and the limits of agreement ranged from −47.2 to 24.6. Visual inspection indicates that the scatter increases with increasing values of AHI, reflecting a trend of the device to overestimate the indexes at relatively lower AHI values and underestimate them at higher AHI values (Figure in the online-only Data Supplement).

Table 1. Findings of Sleep Study

Variable*	PSG (n=29)	PAP Device (n=29)	*P* Value
AHI, events/h	28.8±29.7	17.5±16.5	0.002
AHI≥5	24 (82.8)	21 (72.4)	0.37
AHI≥10	19 (65.5)	15 (51.7)	0.12
AHI≥30	11 (37.9)	7 (24.1)	0.22
Apnea index, events/h	7±13.7	7.7±11.4	0.44
Obstructive apnea index	5.1±11.9	5.5±8.8	0.31
Central apnea index	1.9±4.7	2.3±4	0.009
Hypopnea index, events/h	20.9±18.4	9.8±7.5	<0.001
RERA index, events/h	1.3±3.2	3.1±3.5	0.003
Mean O_2 saturation, %	95.2±2.3		

AHI indicates apnea-hypopnea index; PAP, positive airway pressure; PSG, polysomnography; and RERA, respiratory effort related arousal.

*Values expressed as means±SD or absolute number (percentage of total).

Discussion

In the present study, we found an excellent accuracy of PAP device for predicting SA in acute stroke setting. The optimal PAP device AHI threshold to identify the presence of SA was 5 or 7 events/h, depending on the AHI value chosen on polysomnography (≥5 or ≥10 events/h). For severe SA, the threshold of 18 events/h predicted an AHI≥30 events/h on manually scored polysomnography with high sensitivity and specificity.

Overall, there was a good agreement between PAP device on diagnostic mode and manual scoring on polysomnography for respiratory events detection. The lower agreement observed for HI and RERAI was expected since different criteria are used for scoring them by the 2 methods. Indeed, PAP device use only airflow to detect airway events, whereas the polysomnography scores are also based on arterial oxygen saturation, respiratory effort, and arousals. Furthermore, the respiratory indexes reported by PAP device are calculated by hours of use, and the indexes on polysomnography by hours of sleep.

PAP device algorithms tended to overestimate the AHI when the manually scored AHI value was low and underestimate it when manually scored was high. There was a marked underestimation of AHI by PAP device when compared to polysomnography in 2 of our patients, who showed a high HI and short total sleep time on manually scored polysomnography. Therefore, most of the scatter on AHI comparison was due to differences in the criteria used for hypopnea detection and respiratory index calculation by the 2 methods.

The current findings are in accordance with previous studies in the general population that used a similar device during overnight polysomnography.[6,7] Li et al[6] evaluated 45 adults with SA and found a high accuracy of PAP device at AHI of 10 events/h (sensitivity=0.92; specificity=0.84). Likewise, the HI and RERAI detected by PAP device were poorly correlated with polysomnography (intraclass correlation coefficient, 0.25 and 0.10, respectively).

Few studies reported the use of PAP device in diagnostic mode in stroke patients,[8,9] but only one compared it with a standard polysomnography.[3] Bassetti et al[3] assessed sleep breathing with polysomnography and automatic continuous positive airway pressure device (Autoset, ResMed) in 31 patients within the first 9 days after stroke. They found a good correlation (r^2=0.75) between AHI as determined by polysomnography and the device. However, that study has not provided data concerning the types of respiratory events and has not focused on the accuracy of PAP device for different AHI values. To our knowledge, this is the first study that thoroughly compared device-detected events to manually scored polysomnography for SA detection in patients with acute stroke.

This study has limitations. First, the small sample size, which is justified by the complexity of performing a sleep study in the acute stroke setting. Second, we excluded patients with clinical instability, lowering of consciousness level,

Table 2. ROC Curve Values for Different AHI

PSG AHI	AUC	*P* Value	PAP Cutoff	Sensibility, %	Specificity, %	PPV, %	NPV, %	LR+	LR–
≥5	0.94	0.002	5	83	80	95	50	4.2	0.21
≥10	0.96	<0.001	7	89	80	89	80	4.5	0.13
			10	79	100	100	71	…	0.23
≥30	0.97	<0.001	18	91	94	91	94	16.4	0.10
			30	54	94	86	77	9.8	0.48

AHI indicates apnea-hypopnea index; AUC, area under the curve; LR–, negative likelihood ratio; LR+, positive likelihood ratio; NPV, negative predictive value; PAP, positive airway pressure; PPV, positive predictive value; PSG, polysomnography; and ROC, receiver operating characteristic.

severe heart and lung diseases. This may have influenced the finding of a low rate of central apneas. Third, these results should apply more directly to the model of PAP device used and may not be completely generalizable to other devices with different algorithms.

Conclusions

The PAP device on diagnostic mode proved to be accurate for predicting SA in the setting of acute stroke and was well tolerated. Given the high frequency of SA in acute stroke patients, the complexity and high cost of a full polysomnography, PAP device on diagnostic mode can aid in SA detection in this setting.

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Disclosures

Dr Pontes-Neto has served as speakers in educational meetings of Boehringer Ingelheim, Medtronic, and Pfizer for which he has received personal fees. The other authors report no conflicts.

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