# Instrumentation and Scoring Validity of Polysomnographic Mouth Leak Events During Treatment with Nasal Continuous Positive Airway Pressure

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## Objectives

Treatment with nasal continuous positive airway pressure (nCPAP) is common but adaptation to nCPAP is often difficult, leading to inadequate treatment. Mouth breathing in sleep has been observed before and during use of nCPAP and has been associated with reduced nCPAP compliance. We sought to characterize mouth breathing with attention to signal instrumentation, event definition, inter scorer reliability, distribution according to sleep stages and associated polysomnographic events.

## Methods

Seven patients with obstructive sleep apnea (OSA) were studied with custom nocturnal polysomnography. These patients (5 men, age 31-66) were selected based upon stable use of nCPAP for at least 1 month, and the absence of severe neurological or cardio-respiratory disease.

Tidal volume was measured with a pneumotachometer in line with their nCPAP (range 7 to 15 cm $H_2O$). Oral breath signal was generated with a simultaneous peri-oral pressure transducer as well as a polyvinylidene fluoride (PVDF) film airflow sensor (Figure 1). Two independent certified scorers (RPGST, DABSM) reviewed the polysomnographic record independently and scored the 30-second epochs of sleep by pre-determined written scoring criteria. Scoring rules were developed based upon categorization of the observations. "Fast" events are defined as those with definite oscillations with a frequency of 1 Hz or more. "Slow" mouth leaks were defined as lower frequency events of less than 1 Hz in phase with tidal breathing with concomitant increase of the nCPAP leak signal of at least 3 liters per minute over baseline. Concordance measures for presence or absence of a fast or slow mouth leak events were calculated as percent agreement and Cohen's kappa.

## Results

Mouth breathing during calibration and in sleep shows both a relatively fast frequency 'puffing' waveform (Figure 2) and a slow waveform in phase with tidal breathing (Figure 3). The fast 'puffing' appeared during stable REM and NREM sleep, as well as immediately before and during cortical arousals from sleep (Figure 4). Slow events occurred more frequently and were associated with stable sleep, as well as persistent hypopneas in sleep despite nCPAP. Loss of the peri-oral pressure transducer signal occurred in every study where interpretable signal lasted at best for 16% of the night's epochs. Overall agreement was 0.95 for fast and 0.90 for slow events. Kappa values were 0.90 for fast and 0.80 for slow events.

**Table 1:**
**Frequency of Sleep Epochs With Mouth Leak Events**

| *Sleep Stage* | *Fast Mouth Leak (% epochs)* | *Slow Mouth Leak (% epochs)* |
|---|---|---|
| 1 | 26.4 | 22.2 |
| 2 | 25.8 | 47.2 |
| 3 & 4 | 7.0 | 42.8 |
| REM | 7.3 | 30.5 |

Figure 1: Sensors are placed below the nasal CPAP mask with the oral cannula placed on the upper lip and the PVDF sensor on the lower lip.

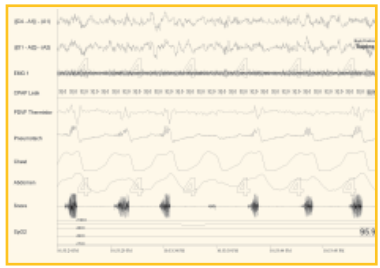

Figure 2: Fast mouth leak events (PVDF sensor channel) with snoring on CPAP (30 second epoch).

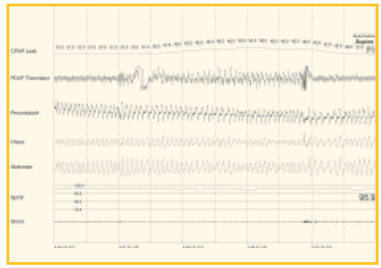

Figure 3: Slow mouth leak events (PVDF sensor channel) with increase in CPAP leak (5 minute epoch).

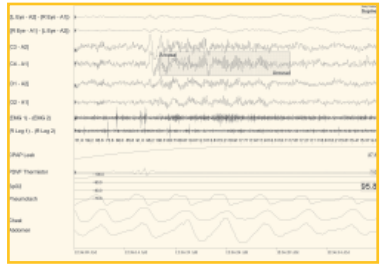

Figure 4: Fast mouth leak event (PVDF sensor channel) preceding a micro-arousal from sleep (30 second epoch).

## Conclusions

The mouth leak events are clearly discernible on the polysomnographic record. These events may be part of stable breathing in sleep, may accompany arousals from sleep, or may be a source of sleep disruption in patients treated with nCPAP.

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