

# Irregular Respiration as a Marker of Wakefulness During Titration of CPAP

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## KEY FINDINGS:

- It is possible to **manually** identify the transition from sleep to wake from the flow signal alone.
- It is possible to **automatically** identify the transition from sleep to wake from the flow signal alone.
- This study describes the development of **SensAwake™**, which automatically senses the transition from the sleep state to wake state and promptly reduces the delivered pressure to facilitate the return to sleep.

## AIM:

- To examine the ability to detect transitions from sleep to wakefulness using the Continuous Positive Airway Pressure (CPAP) flow signal alone and to automate this recognition.

## METHODS:

### PHASE 1 — Evaluation of the relationship between the visual onset of irregularity and EEG:

- 20 sleep apnea patients (Respiratory Disturbance Index (RDI) 13-119/hr) underwent full nocturnal polysomnography (PSG).
- Periods of irregular respiration were manually identified from the flow signal alone while the scorers were blinded to sleep staging.
- Sleep and arousals (as defined by the American Association of Sleep Medicine (AASM)) were manually scored using traditional PSG measures (EEG, EOG and EMG).
- Results from manually marked periods of irregular respiration were compared to scored sleep.

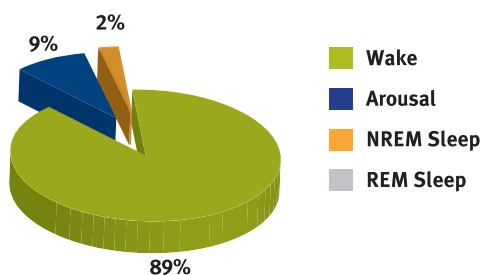
### PHASE 2 — Automated detection of irregular respiration:

- 50 PSG studies were scored manually for periods of irregular respiration from the flow signal alone, and were used to train an Artificial Neural Network (ANN).
- The trained ANN was then tested for accuracy using the flow signals from 24 different PSG studies.
- Results from the ANN were compared to EEG defined wake and arousals (as defined by the AASM).

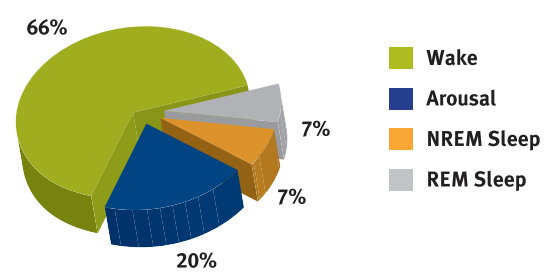
## RESULTS:

- Phase 1 — The positive predictive value of irregular respiration to detect the transition from sleep to wake was 0.89 and 0.98 for wake and arousal combined.
- Phase 2 — The positive predictive value of irregular respiration identified by the ANN was 0.86 for wake and arousal combined.

Percentage of events manually identified from the flow signal alone that were associated with Wake, Arousal, NREM Sleep and REM Sleep on PSG signals



Percentage of events automatically identified by the ANN from the flow signal alone that were associated with Wake, Arousal, NREM Sleep and REM Sleep on PSG signals



## CONCLUSIONS:

- The presence of an irregular respiratory pattern was highly predictive of the transition from sleep to wake.
- Detection of irregular respiration can be automated with an ANN.