AUTOMATIC DETECTION OF SELF-SIMILARITY AND PREDICTION OF CPAP FAILURE

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INTRODUCTION Sleep disordered breathing is a significant risk factor for cardiometabolic and neurodegenerative diseases. Tolerance and efficacy of continuous positive airway pressure (CPAP) is often poor. **High loop gain** (HLG) is a driving mechanism of central sleep apnea or periodic breathing.

The current study aimed to develop a computational approach to detect HLG based on **self-similarity** in respiratory oscillations during sleep solely using breathing patterns, measured via **Respiratory Inductance Plethysmography** (RIP). To quantify the potential utility of the developed similarity metric, the presented algorithm was used to predict acute **CPAP failure**.

METHODS We developed an **automated algorithm** for **detecting apneas** as periods with reduced breathing effort in the RIP signal. The algorithm calculates self-similarity between consecutive periods of apnea or hypopnea as shown in **Figure 1**. Working under the assumption that high loop gain induces self-similar respiratory oscillations and increases the risk of failure during CPAP, the full night similarity, computed during diagnostic non-CPAP polysomnography (PSG), was used to predict failure of CPAP (central apnea index (CAI)>10). Central apnea labels are obtained both from manual scoring by sleep technologists, and from the automated algorithm. The Massachusetts General Hospital (MGH) sleep database was used, including 2466 PSG pairs of diagnostic and CPAP titration PSG recordings.

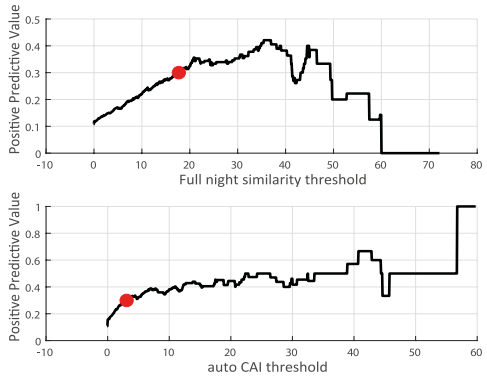

Figure 2

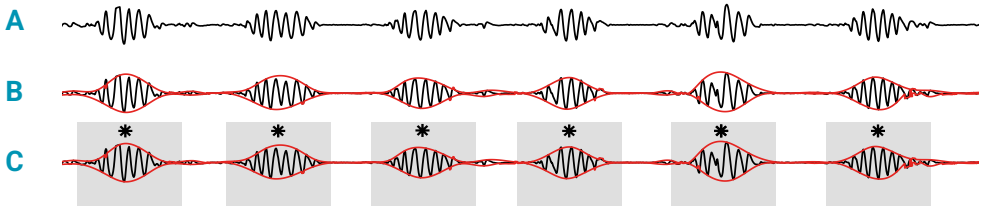

Figure 1 – calculation of self-similarity
A. Line of 5-minute respiratory tracing (abdominal RIP band)
B. (B) Upper and lower envelope
C. (C) Peaks detected (*) and convolution applied

RESULTS Diagnostic CAI based on technologist labels predicted failure of CPAP with an **AUC of 0.82 ±0.03**. Based on automatically generated labels, the combination of full night similarity and automatically generated CAI resulted in an **AUC of 0.85 ±0.02**. The red dot in **Figure 2** shows a PPV of 30%, implying that when similarity is equal to or higher than 17% or auto CAI equal to or more than 3 events per hour of sleep, the probability of CPAP failure was 30%.

CONCLUSIONS This study showed that central apnea labels can be derived in an automated way. The proposed self-similarity feature, as a surrogate estimate of expressed respiratory high loop gain and computed from easily accessible effort signals, can detect periodic breathing regardless of admixed obstructive features such as flow-limitation, and can aid prediction of CPAP failure or success.