

Artificial Intelligence to predict arousals in Home Sleep Testing without Electroencephalography

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Introduction

The American Academy of Sleep Medicine recommends scoring hypopneas terminating in either oxygen desaturation or arousals¹. A limitation of Home Sleep Tests (HST) or Type III sleep recordings, when EEGs are unavailable, is not scoring hypopneas that terminate in arousals^{2,3}. This lowers the average apnea-hypopnea index (AHI) in Type III recordings and disproportionately affects patients who predominantly have hypopneas that terminate in arousals³.

Here we report on a deep neural network, Nox BodySleep 2.0 experimental prototype (see Figure 2), that predicts arousals and sleep stages using non-EEG signals. The model uses abdomen and thorax respiratory inductance plethysmography (RIP) and activity signals. The model outputs arousal events; and Wake, rapid-eye-movement (REM), and non-REM sleep epochs.



Figure 1: Image of Type III recording set-up using the Nox T3s Recorder and accessories

Methods

The model was trained on ~3,200 Type I sleep recordings from the United States, Europe, and Asia. The validation was performed using retrospective data, comprised of 2,407 Type I recordings (also referred to as in-lab PSG recordings) from clinical sleep labs in the United States that have previously been manual scored by sleep technologist. It should be noted that only a subset of the signals was used by the model during training and validation since Nox BodySleep 2.0 is meant for Type III recordings. Only signals that are typically collected during Type III recordings were used.

The scoring performance of the Nox BodySleep 2.0 model was measured using epoch-based sensitivity, specificity, and accuracy for scoring arousals in comparison to manual scoring. Furthermore, the clinical performance was validated by the sensitivity, specificity, and accuracy for AHI severity classification for the diagnostic cutoff thresholds of AHI ≥ 5 and AHI ≥ 15 . The severity classification derived from the automatic scoring of the Nox BodySleep 2.0 model was also compared to manual scoring. For comparison, the performance of automatic scoring of Type I recordings (compared to manually scored Type I recordings) and Type III recordings (compare to manually scored Type III recordings) was also reported.

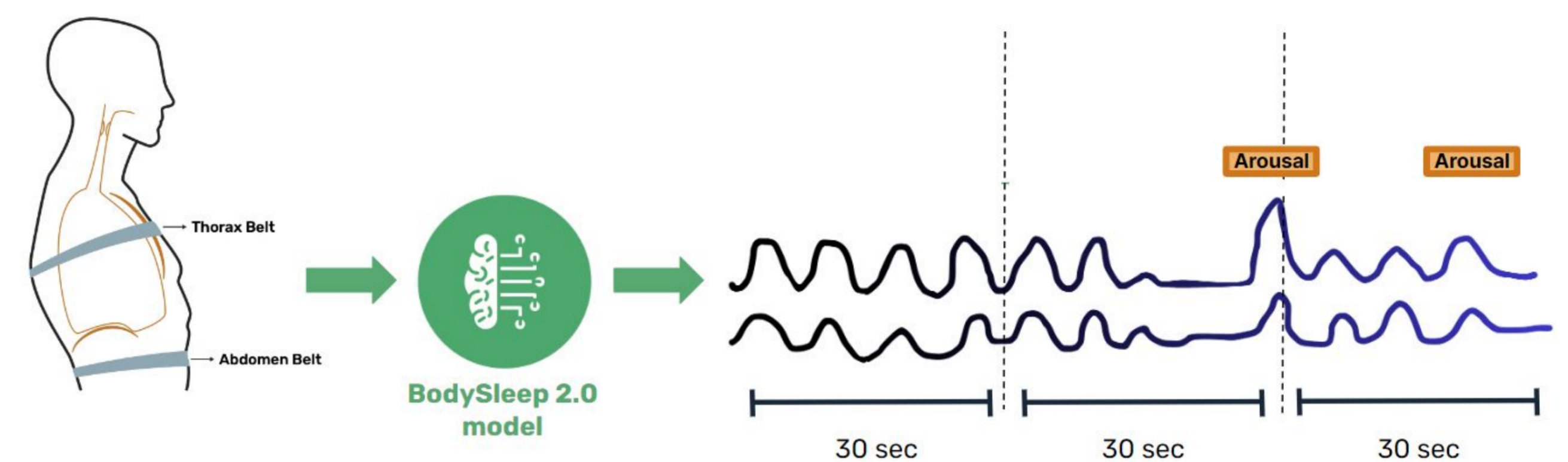


Figure 2: Conceptual illustration of arousal scoring using Nox BodySleep 2.0

Results

The model's sensitivity, specificity, and accuracy for arousal scoring is shown in Table 1.

Table 1: Sensitivity, specificity and overall accuracy of epoch-level agreement when compared to manual scoring

	Sensitivity	Specificity	Accuracy
Arousal	65%	85%	80%

The model's sensitivity, specificity, and accuracy for AHI severity classification is shown in Table 2. The performance of Type I and III automatic scoring is also shown for comparison.

Table 2: Performance of Nox BodySleep 2.0 with regards to OSA severity classification compared to Type III automatic scoring and Type I automatic scoring

Threshold	Sensitivity	Specificity	Accuracy
Nox BodySleep 2.0			
AHI ≥ 5	95%	88%	94%
AHI ≥ 15	86%	97%	92%
Type III automatic scoring			
AHI ≥ 5	75%	95%	77%
AHI ≥ 15	60%	99%	81%
Type I automatic scoring			
AHI ≥ 5	96%	95%	96%
AHI ≥ 15	89%	98%	96%

Conclusion

The model is a promising method of providing conclusive results from Type III sleep recordings. The model-based AHI is closer to the AHI from automatic Type I recordings than when using manually scored Type III recordings. The AI model was trained on a large and diverse dataset and validated on data from a clinical population from the United States. Predicting arousals in Type III recordings (without EEG signals) improves patients' access to conclusive sleep apnea testing, and may improve health equity and the operation of sleep clinics.

References:

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