Oximetry Analysis in Prediction of Abnormal AHI and MWT

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Oxygen saturation

Apnea-hypopnea index (AHI) is the main objective criteria in the diagnosis of obstructive sleep apnea syndrome. Because arterial oxygen saturation (SaO2) correlates with the apnea-hypopnea index, oximetry has been used in screening applications [1]. In the present study we wanted to compare different SaO2 analysis methods in the prediction of abnormal AHI and in the prediction of the impaired ability to maintain wakefulness (MWT).

AHI, MWT

We studied 183 train drivers and controllers in a sleep laboratory. Full night polysomnography was followed by the Maintenance of Wakefulness Test (MWT) on the following day. Respiratory disturbances were monitored with thermistor and static-charge-sensitive bed (SCSB). Apnea-Hypopnea index above 15 /h was chosen for an abnormal cut-off level and the mean sleep latency below 19.4 min (of the four consecutive 40 min MWT tests) was similarly considered abnormal.

Maximum, mean, minimum, SD,....

Beside the maximum, mean, minimum and the standard deviation of the nocturnal SaO2, oxygen desaturation indexes (ODI) were calculated at 2-6 /h cut points. Also, the cumulative time spend below saturation values of 90-98 % (TIM 90-98) were assessed and a modified, deep ODI 4-95 (desaturation of at least 4 % reaching at least 95 %), the variability (VA) of the SaO2 curve and a weighted cumulative time spend below certain saturation values (SIT) were calculated [2, 3, 4]. The used analysis methods were evaluated by the receiver operating characteristics (ROC) area-under-the-curve (AUC) statistics for the defined abnormal AHI and MWT levels.

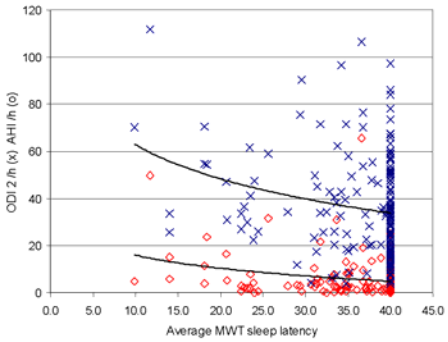

Figure 1. Relationship between average MWT sleep latency (min) and AHI /h and ODI 2 /h.

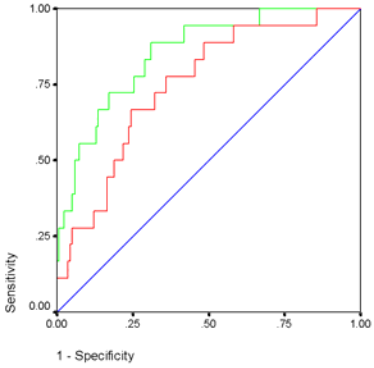

Figure 2. ROC curves for detecting abnormal AHI (>15 /h) using ODI 2 /h (red) and ODI 6 /h (green).

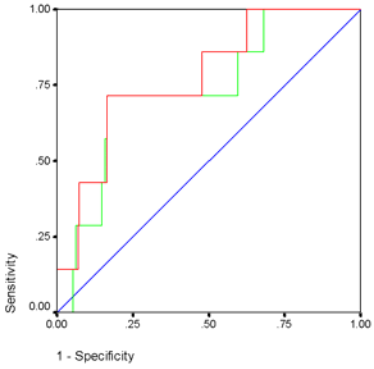

Figure 3. ROC curves for detecting abnormal MWT (<19.4 min) using ODI 2 /h (red) and ODI 6 /h (green).

AHI > 15/h, MWT <19.4 min

18 out of the 183 analyzed subjects had AHI over 15/h and and 7 had MWT less than 19.4 min. For the abnormal AHI, the largest AUC values were obtained with ODI 6 (0.85), followed by ODI 5 (0.84), ODI 4 (0.83), ODI 4-95 (0.83), ODI 3 (0.80), TIM 92 (0.80), TIM 90 (0.77), TIM 94 (0.77) and SIT 94 (0.77). For the abnormal MWT, the largest AUC values were obtained with AHI (0.83), ODI 2 (0.78), ODI 3 (0.76), ODI4-95 (0.74), ODI 4 (0.74), ODI 5 (0.74) and ODI 6 (0.73). Neither the variability (VA) or the weighted cumulative time (SIT) predicted the abnormal AHI and MWT values significantly.

ODI 6 for AHI, ODI 2 for MWT

The results show that different parameters of the the used oximetry recordings predict respiratory disturbances and sleepiness. For the estimation of an abnormal apnea-hypopnea index (AHI>15 /h), tighter criterias like ODI 6 /h would provide the highest prediction. For the estimation of abnormal sleepiness (MWT<19.4 min), the use of AHI proved to be the most predictive, followed by ODI 2, ODI 3 and ODI 4-95. Overall predictive value of SaO2 was higher for AHI than for MWT abnormality.

References
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[2] Chesson AL, Anderson MW, et al. Comparison of two methods of quantitative assessment of hypoxemia in patient with sleep disorders. Sleep Medicine 2001;37-45.
[3] Epstein LJ, Dorlac GR. Cost-effectiveness Analysis of Nocturnal Oximetry as a Method of Screening for Sleep Apnea-Hypopnea Syndrom. Chest 1998; 113: 97-103.
[4] Levy P, Pepin JL, et al. Accuracy of Oximetry for Detection of Respiratory Disturbances in Sleep Apnea Syndrome. Chest 1996; 109:395-399.

Table 1. Oximetry parameters in AHI <15 /h, >15 /h and MWT >19.4 min, <19.4 min groups.

	n	AHI	Mean	SD	Min	Deep	ODI2	ODI4	ODI6	VA	TIM96	TIM94	TIM92	TIM90	SIT96	SIT94
AHI<15/h	**165**	**3.7**	**95.1**	**1.9**	**56.3**	**6.2**	**34.3**	**6.2**	**1.9**	**1.6**	**4.7**	**1.0**	**0.3**	**0.2**	**9.9**	**3.2**
SD		3.5	1.0	0.9	7.6	5.9	19.9	5.9	2.0	0.6	2.4	1.3	0.7	0.4	8.2	5.3
AHI>15/h	**18**	**25.9**	**94.0**	**2.7**	**57.1**	**19.2**	**54.8**	**19.2**	**8.8**	**2.3**	**6.1**	**2.5**	**1.0**	**0.6**	**19.5**	**9.5**
SD		13.2	2.1	1.5	9.6	18.0	25.5	18.0	13.7	1.3	2.3	2.2	1.5	1.1	18.3	15.1
MWT>19.4 min	**176**	**5.4**	**95.0**	**2.0**	**56.3**	**7.2**	**35.4**	**7.2**	**2.5**	**1.6**	**4.8**	**1.1**	**0.4**	**0.2**	**10.6**	**3.6**
SD		7.8	1.2	1.0	7.8	8.6	20.6	8.6	5.1	0.7	2.4	1.4	0.7	0.5	9.8	7.0
MWT<19.4 min	**7**	**16.5**	**94.3**	**2.3**	**58.0**	**14.0**	**60.2**	**14.0**	**4.1**	**2.5**	**5.7**	**2.5**	**1.2**	**0.5**	**17.5**	**8.0**
SD		16.2	1.6	1.2	8.1	10.5	28.4	10.5	3.0	1.4	2.7	2.7	1.8	0.8	13.7	9.3