Evaluation Of The Odds Ratio Product During The Psychomotor Vigilance Test

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Introduction

- One of the main shortcomings of the Rechtschaffen and Kales (R&K) and AASM scoring systems is their inability to score microsleep episodes occurring within epochs scored as wake. Episodes of drowsiness or decreased vigilance are not captured in standard polysomnographic tests of sleepiness such as the MWT because only the predominant sleep stage in a 30- second epoch is identified.

- The Michele scoring system generates the Odds Ratio Product (ORP), a new continuous index of sleep depth calculated in 3-second epochs from the electroencephalogram (EEG). ORP is based on the power of all EEG frequencies occurring in a 3-second second epoch and reflects a continuum from wide awake to deep sleep. ORP values range from 0-2.5 with a value of 1.5 seen as a cutoff between wake and sleep.

- The psychomotor Vigilance Test (PVT) has been shown to be sensitive to sleepiness associated with sleep deprivation, circadian changes, and sleep apnea. In the 10-minute test, subjects are exposed to over ninety stimuli requiring a response. Lapses are defined as reaction times slower than 500 ms with increasing number of lapses reflecting reduced performance.

- The PVT has not been accurately tested in conjunction with simultaneous EEG recordings because of artifacts stemming from movement and eye blinks which compromise the EEG.

Methods

- Five subjects with diagnoses of pathological sleepiness and two sleep deprived normal volunteers (limited to 4 hours of sleep the previous night) underwent EEG recordings while simultaneously completing four 10-minute PVT sessions at two hour intervals. No sleep was allowed during the intervals.

- Records were scored for ORP. Because vigilance is a frontal lobe function, recordings were made from F3-A2 and F4-A1 necessitating the development of an algorithm to filter eye blink artifacts. Mean ORP values from the two frontal EEG leads were computed for each 3-second epoch.

- The time of each PVT stimulus was matched with the corresponding ORP value (9 to 3 seconds average, when applicable). The PVT reaction times and lapses were matched to the corresponding mean ORP value.

Results

- Results from the final PVT session (PVT4) and the final session of the MWT (MWT4) for 2 narcoleptic patients and mildly sleep deprived normal are presented (Table 1).

- Subject 1: This female subject has a longstanding history of narcolepsy. She showed considerable sleepiness throughout her MWT4 with a dramatic decrease in ORP in the final minute before R&K defined sleep onset. Her performance on the PVT4 showed marked sleepiness (very low ORP) when lapses occurred (Figures 1, 2).

- Subject 2: This was a male narcoleptic with severe cataplexy. Overall, his mean ORP during MWT4 showed mild sleepiness. However, at sleep onset his ORP was consistent with profound sleepiness. During the PVT4, lapses were consistent with ORP values that suggest mild sleepiness(Figures 3, 4).

- Subject 3: This was a partially sleep deprived normal male. His mean ORP for MWT4 showed higher values throughout the session with only a mild decrease at sleep onset. Lapses occurred primarily at the end of the PVT4 (Figures 5, 6).

- Lapses by minute showed the effects of fatigue in all subjects.

Figure 1. ORP values per minute during PVT4 in narcoleptic subject 1.
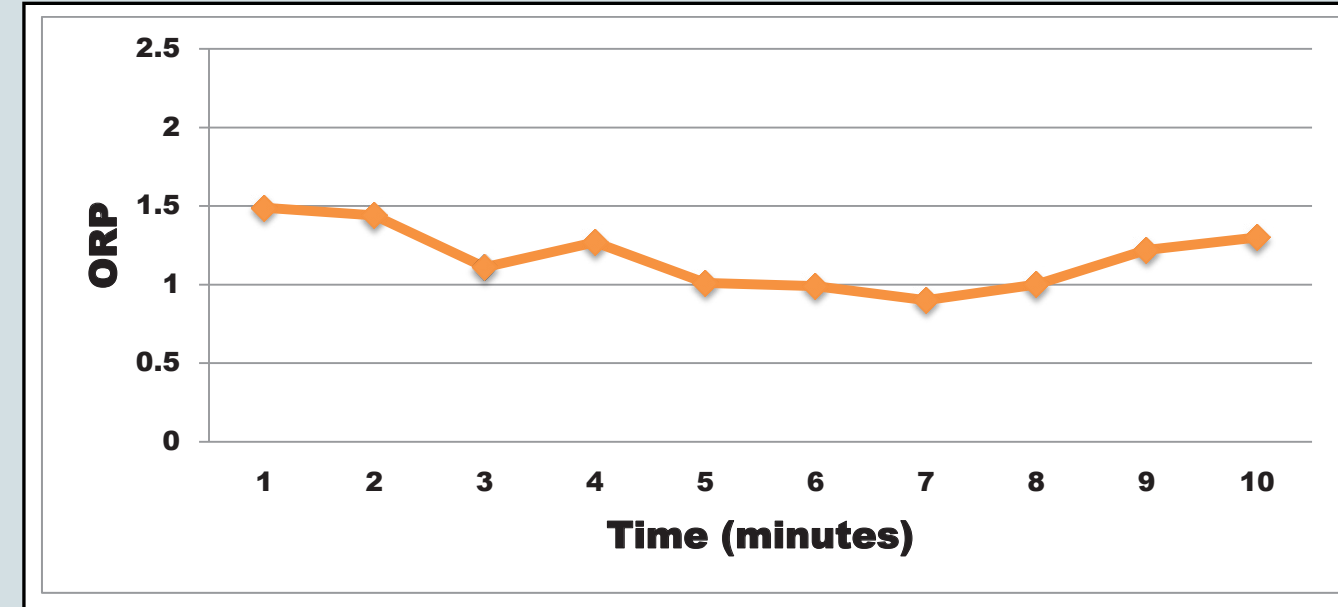

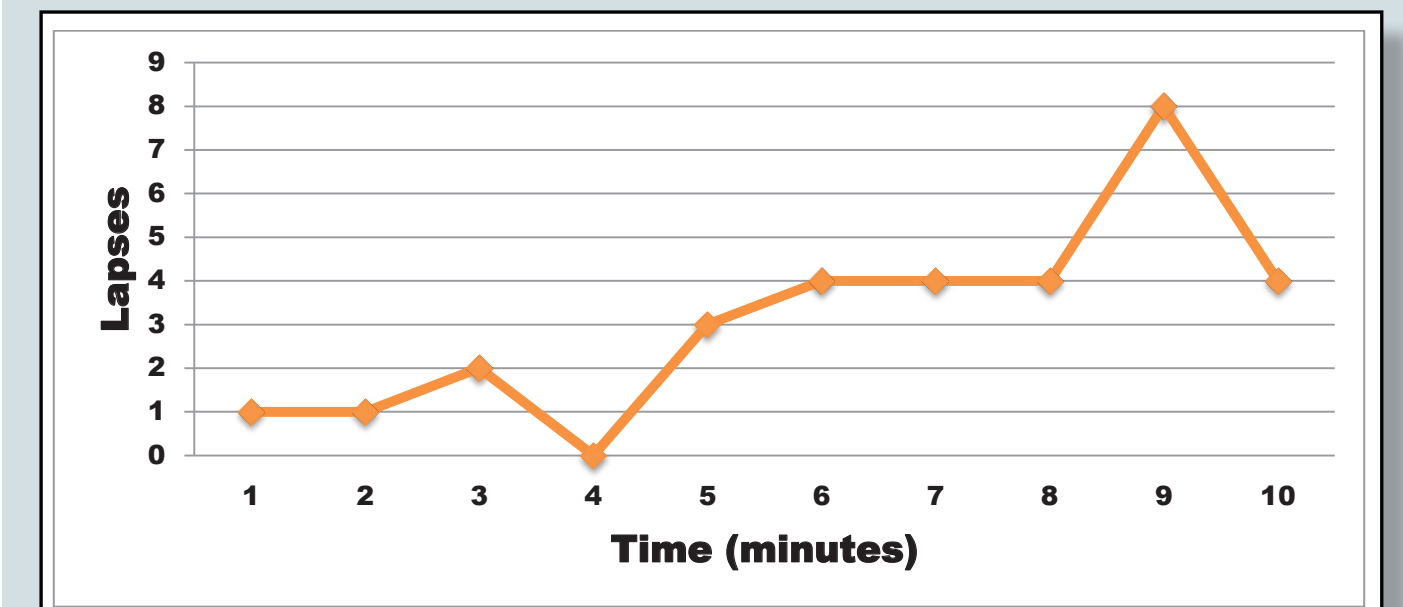### Figure 2. Number of lapses per minute during PVT4 in narcoleptic subject 1.

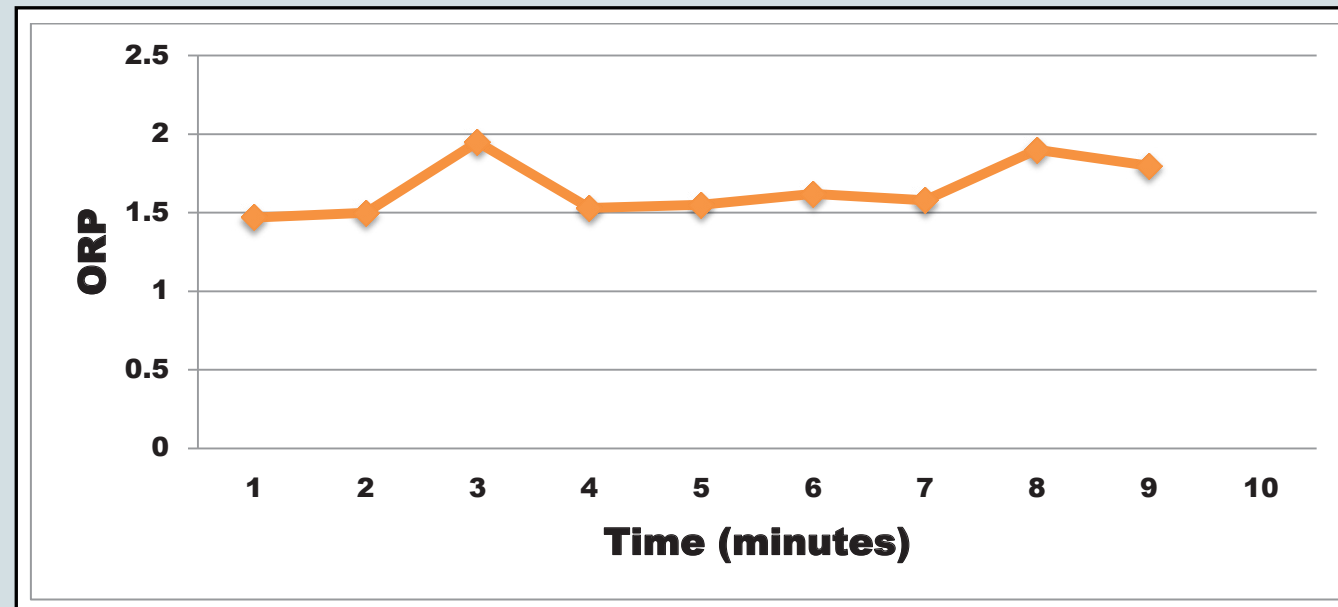### Figure 3. ORP values per minute during PVT4 in narcoleptic subject 2.

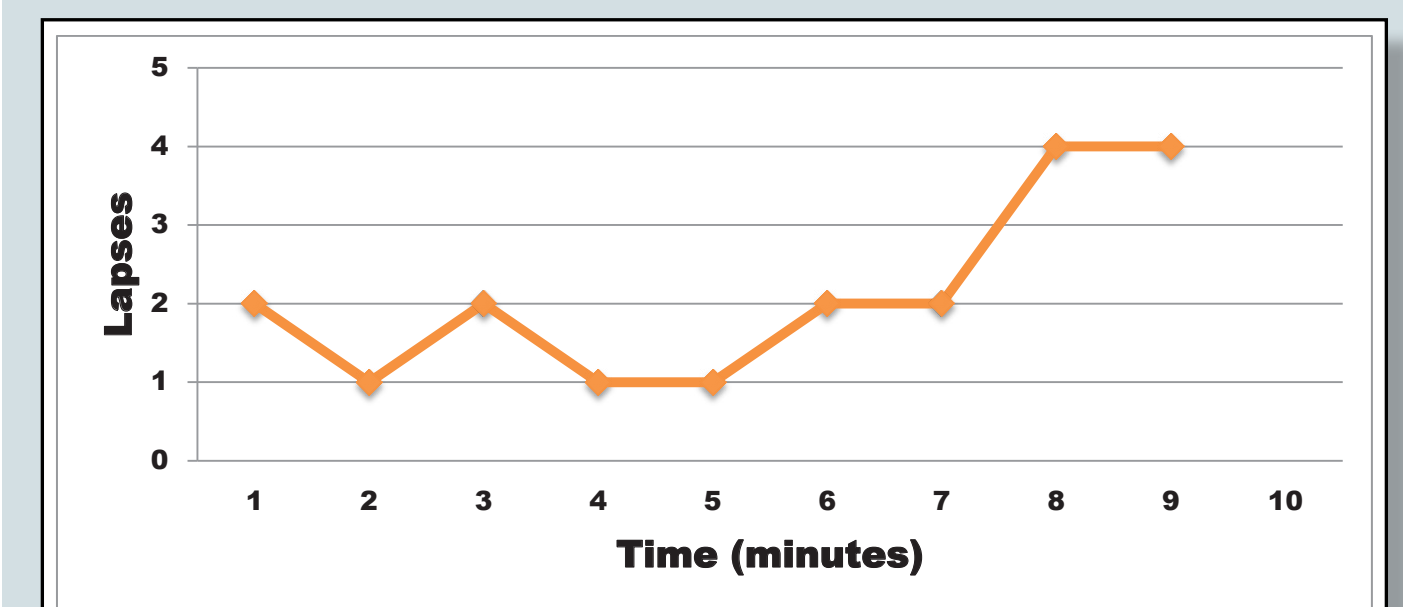### Figure 4. Number of lapses per minute during PVT4 in narcoleptic subject 2.

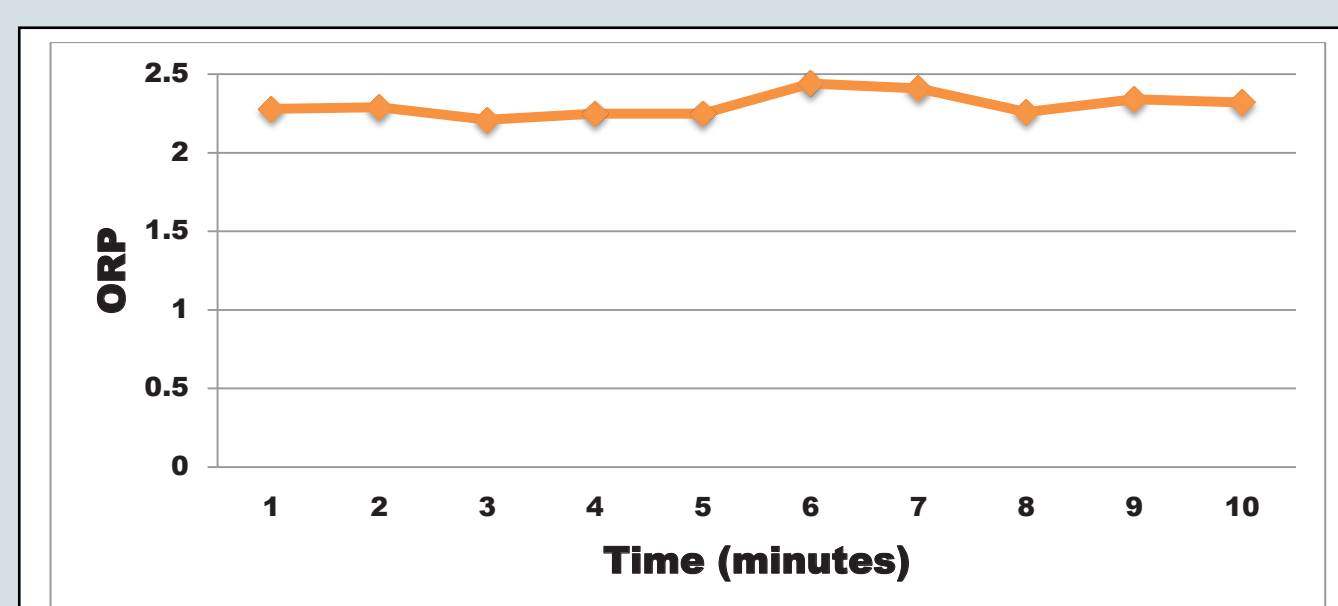### Figure 5. ORP values per minute during PVT4 in normal subject 3.

Figure 6. Number of lapses per minute during PVT4 in normal subject 3.

Table 1. Summary of ORP results during MWT and PVT

SubjectID	Diagnosis	MWT4 ORP Mean ± SD	MWT4 First minute ORP Mean ± SD	MWT4 Last minute ORP Mean ± SD	PVT4 ORP at lapse Mean ± SD
1	Narcolepsy	1.39 ± 0.69	1.74 ± 0.56	0.86± 0.53	0.93± 0.47
2	Narcolepsy	1.46 ± 0.71	1.44 ± 0.56	0.78± 0.42	1.55± 0.41
3	Normal*	2.18 ± 0.47	1.73 ± 0.89	2.15± 0.24	2.17± 0.32

* Subject had 4 hours of sleep
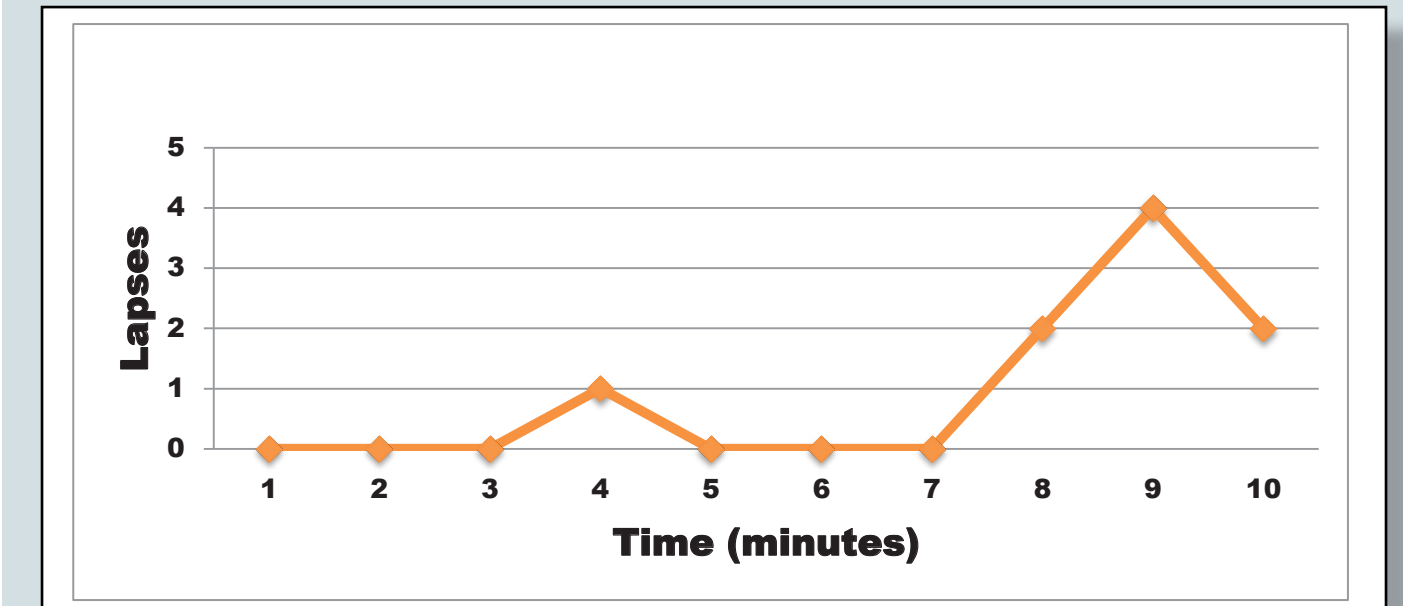
Conclusion

While quite preliminary and only partial, these results support the concept that ORP decreases at sleep onset for both normal and narcoleptic subjects. Overall, narcoleptic subjects show lower ORP values suggesting that they may have a tonic sleepiness that, without stimulant medication, rarely reaches levels of alertness seen in normals. As a result, they may be prone to greater sleepiness with performance fatigue.

References

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