Circadian and ultradian rhythms in sleep structure and body temperature during an ultrashort sleep-wake schedule

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OBJECTIVE & STUDY DESIGN

- Historical research on sleep-wake structure: short (3.5 h wake/21.5 h attempted sleep) and ultrashort (6 min wake/13 min attempted sleep) sleep-wake schedules (WESTERHOFF et al., 1969; CROCKETT & DUSICK, 1977; LAMTS 1984, LAMTS & DUSICK, 1990). Strong circadian drive of sleep propensity rendered, with maximum around 3 a.m. and minimum around 8 to 10 a.m.

- Adoption of ultrashort sleep-wake schedule design to order to:
  - assess circadian drive of various physiological and subjective variables in comparison to well-established circadian marker: core body temperature
  - examine effect of core body temperature measurement (retro) novel method (oral, i.e. in the ear)
  - investigate phase relationship between potential ultrashort-driven variables

- Study design: 80 hours of alternation between 20 min wakefulness and 10 min of rest (with the instruction to fall asleep as fast as possible)

- Continuous EEG, ECG, and body temperature recording

- Rating of subjective sleepiness during wakefulness on visual analog scale

- 13 young healthy volunteers, 6 subjects (4 males, 2 females), 23.4 ± 4.7 years, range 18-30 years completed their trial

DATA ANALYSIS & RESULTS

- Figs. 4-6: Subjects of 6 and 8 (left or right figures, respectively). Following measures were averaged over each attempted sleep episode: arterial & rectal body temperature, heart rate (HR) and heart rate variability (SDNN) in the upper panel. Amount of non-REM and REM sleep in the lower panel. Additionally, lower panels show subjective sleepiness (SS), specified during wake episodes. Ratings of subjective sleepiness clearly show circadian as well as ultrashort periodic variations. During periods of non-REM sleep, a decrease of non-REM sleep can be observed. Also, the amount of non-REM sleep is accumulating in the second half of the trial. While amount of non-REM sleep in the second night is peaking, the amount of REM sleep is remaining.

- Tab. 1-4: Correlation coefficients of averaged sleep episode measures of subject 4 (see also fig. 6).

CONCLUSIONS

- Body temperature contains strong circadian components.

- Second strongest circadian modulation is seen in heart rate and subjective sleepiness, the latter also displays distinct circadian components.

- However, the scale of subjective sleepiness contains the highest inter-individual variability.

- Arousal measurement of body temperature appears superior to metal measurement (21.5 h) in more cases the amplitude of the arterial circadian component is higher than in the metal measurement. (C) activity of ultrashort measurement contains less interrupted moments than metal HR. (D) It is more comparable to wear and less prone to photoplagia of place.

- In a measured period of about one day, different circadian invasions and outlined in COSINOR (6) is somewhat explainable because of meaninglein interrupted visits. However, in most cases, excess in heart rate and subjective sleepiness coincide with extremes of body temperature.

- Reciprocal relationship found between non-REM and REM sleep, significant for almost every subject.