Improving the Utility of Interpreting Sleep Fragmentation

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Recognition of the importance of EEG arousals in determining daytime function was facilitated by the development of the multiple sleep latency test (MSLT) as an objective measure of physiological sleepiness. Once the MSLT was incorporated into routine clinical practice, Roth et al. found that of all EEG-based sleep parameters, shifts to stage one sleep were the best predictors of sleepiness, as measured by the MSLT, in patients with sleep apnea. This was an unexpected finding given the bias at the time that total sleep time, amount of slow wave sleep, or amount of REM sleep would provide a better indicator of the degree to which sleep was restorative. Carskadon et al. reported that “brief arousals” had a significant correlation with MSLT score in older adults. At this time, each study used a unique approach to quantifying brief arousals, as there was no standard definition to allow systematic evaluation of this aspect of sleep. Early work in this area sought to establish an operational definition of arousal that provided the best prediction of daytime sleepiness. A consensus process ultimately led to the American Sleep Disorders Association (ASDA, now called the American Academy of Sleep Medicine) definition for quantifying EEG arousals in 1992.

Subsequent to that important event, research on sleep fragmentation has been steady, but sparse. There have been attempts to refine the definition of arousal given that the ASDA measure does not uniformly provide robust correlations with daytime sleepiness. The bulk of the work exploring other approaches to quantifying arousals has occurred in the area of “autonomic” or “subcortical” arousals. These studies have primarily focused on arousals that occur in patients with sleep disordered breathing. A comprehensive review of these studies did not find that there is sufficient justification to include measurement of autonomic arousals as a routine clinical procedure in sleep study interpretation.

A recent study reports significant correlations with sleepiness, as measured by the Epworth Sleepiness Scale, when using a measure of “long arousal,” 15-60 seconds, in patients with obstructive sleep apnea. Further work is needed to assess the utility of this measure in other patient groups, and to assess prediction of objective measures of sleepiness.

Another innovative approach to measuring sleep fragmentation is to evaluate inter-arousal interval. The rationale for this approach is that arousals are presumably important predictors of sleepiness because they interrupt the continuity of sleep and thereby interfere with the restorative function of sleep. Studies producing various schedules of experimental sleep fragmentation suggest that intervals of sleep must be 5-10 minutes to provide restoration (i.e., eliminate daytime sleepiness). A recent study used survival curve analysis to analyze the duration each sleep segment and found differences in this metric between normal sleepers and patients with moderate to severe obstructive sleep apnea.

Despite the attempts described above, in the 15 years since the ASDA definition of arousal was established, no research has demonstrated improvement in predicting objective sleepiness with a new measure of sleep fragmentation. In this issue of the Journal, Bonnet and Arand provide age-related norms for ASDA-defined EEG arousals in normal sleepers. Given routine use of this metric for guiding interpretation of clinical sleep studies, this addition to the literature seems overdue, and is quite welcome. Who has not had a sleep medicine fellow learning how to interpret a polysomnogram ask, “So what is a normal arousal index for a 60-year-old?” As described in this paper, a few studies have reported significant positive correlations between age and arousal index. These results supported the importance of age as a factor in determining the number of arousals, but normative data by decade to use as a basis of comparison has not been available until now. Of interest, number of arousals correlates significantly with nearly all sleep parameters in the direction of indicating decreased quantity and quality of sleep as arousals increase. Given the deterioration of sleep observed in older adults, it is not surprising that the arousal index is double for individuals over the age of 50 years compared with those under the age of 30 years. An additional strength of these data is that the authors report reliability data for the scoring of the arousals. Establishing reliability for scoring arousals is difficult and often overlooked. As the authors note, the samples here are small, and results as they relate to sex in particular need further validation with larger samples.

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