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Recent Advances in Understanding Sleep and Sleep Disturbances in Older Adults

Growing Older Does Not Mean Sleeping Poorly

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ABSTRACT—***Despite commonly held assumptions, growing older does not necessarily result in disturbed or unsatisfying sleep. There is no reason to assume, a priori, that the sleep of an older adult is necessarily problematic; in fact, many high-functioning older adults are satisfied with their sleep. When the various factors that can disrupt sleep—poor health, primary sleep disorders, poor sleep-hygiene practices (e.g., irregular sleep schedules and poor sleeping environments), and so on—are screened out, "optimally" or "successfully" aging older adults, assuming they remain healthy, can expect to experience little further change in their sleep and are not likely to experience excessive daytime sleepiness and the concomitant need to nap regularly during the day. Nevertheless, the majority of older adults, who are not optimally aging, suffer significant sleep disturbances from a variety of causes. Fortunately, our growing understanding of how sleep changes with aging and of the causes of these changes is informing ever-improving treatments for these disturbances, thereby helping to ensure that growing older does not mean sleeping poorly.***

Currently some 37 million Americans are 65 years of age or older, constituting 12.5% of the national population. By 2030, approximately 20% of the U.S. population will be 65 years of age or older. This population change threatens to have a massive negative impact on our already strained healthcare system. Many major physiological changes occur in the context of aging. One such change is an often profound disruption of an older adult's daily sleep–wake cycle; such disruption is associated with poor quality of life, increased morbidity, and possibly increased mortality (Reid et al., 2006).

Sleep is composed of two very different physiological states, rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep. NREM is further divided into three stages, with stage N1 the lightest and stages N2 and N3 progressively deeper (i.e., more and more difficult to be awakened from). Sleep is typically organized into 90-minute cycles of NREM/REM; however, most stage N3 sleep, also called deep sleep or slow-wave sleep because of its characteristic low-frequency electroencephalogram (EEG) profile, normally occurs in the first half of the night, and most REM sleep occurs in the last half of the night. This pattern can be periodically interrupted by periods of wakefulness, which may be infrequent and brief or frequent and of significant duration.

Sleep/wake patterning appears to be regulated by a complex interaction of two processes: a homeostatic sleep drive and a circadian wakefulness drive. The homeostatic sleep drive is time-awake dependent—that is, the longer we are awake, the greater our drive to fall asleep becomes. Under normal conditions this drive reaches its maximum in the later evening. However, if the homeostatic sleep drive were the only mechanism regulating our tendency to sleep, we would all be sleepy in the early evening when we typically have been awake some 12 to 14 hours. Yet, under normal conditions we are not sleepy at this time. This is because the circadian wake drive—which is not time-awake dependent but, rather, has a circadian (24-hour) periodicity—is at its maximum in the evening and works in opposition to accumulated homeostatic need to sleep, keeping us awake despite a strong homeostatic drive to sleep. Sleep only occurs once the circadian drive for wakefulness passes its maximum, moving toward its minimum; this occurs in the

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morning, when homeostatic sleep drive is at its minimum—having been dissipated by a night's sleep. Both of these processes can be influenced by a wide variety of physiological, psychological, and environmental factors resulting in disturbed sleep.

Epidemiological studies have consistently shown that the prevalence of significant sleep complaints grows steadily with advancing age (e.g., Ohayon, 2002; Foley et al., 1995). The most striking change in sleep in older adults is the repeated and frequent interruption of sleep by long periods of wakefulness, possibly the result of an age-dependent change in sleep-homeostatic and/or wake-maintenance processes (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). Older adults are also more easily aroused from nighttime sleep by sounds, suggesting that they may be more responsive to environmental stimuli. Both of these changes are indicative of impaired sleep maintenance and depth and contribute to the characterization of the sleep of older adults as lighter or more fragile than that of younger adults. Other age-dependent changes in sleep include decreases in total sleep time, sleep efficiency (the percent of time in bed spent asleep), slow-wave, and REM sleep, and increases in stages N1 and N2 sleep. These age-dependent changes are mirrored by increased likelihood of napping or falling asleep during the day (Foley et al., 2007). Aging is also associated with a tendency to both fall asleep and awaken earlier and to be less tolerant of phase shifts in time of the sleep/wake schedule, such as those produced by jet lag and shift work (Monk, 2005). All of these changes suggest an age-related breakdown of the normal young-adult sleep/wake cycle.

Clearly sleep changes significantly with advancing age, but the questions remain: Exactly when do these changes occur, what is their cause, and are they treatable and perhaps partially reversible? Common wisdom has held that the changes that characterize the sleep of older adults begin to appear in early adulthood and progress steadily and inexorably across the human life span. Another bit of common wisdom has held that the sleep complaints of older adults are "merely" the result of growing older and that, as a consequence, little can be done to improve the sleep of older adults. Fortunately, recent research fully contradicts these assumptions (Vitiello, 2006).

SLEEP CHANGES IN NORMAL AGING

Since Roffwarg, Muzio, and Dement (1966) published their now-classic paper, it has been assumed that the sleep changes seen in older adults described above begin to appear in early adulthood and progress steadily across the life span. In contrast, a recent and extensive meta-analysis of objective sleep measures across the human life span by Ohayon et al. (2004) indicates that the bulk of the changes seen in adult sleep patterns occur between early and middle adulthood, between ages 19 to 60, and that after age 60 such sleep-pattern changes effectively asymptote, declining only minimally with further advancing age (see Fig. 1; Ohayon et al., 2004).

These findings contradict commonly held concepts of sleep and aging relationships. However, it is important to remember that Ohayon and colleagues used very rigorous selection criteria in choosing the study subjects for their meta-analyses. The approximately 2,400 subjects were not representative of the entire older population but, rather, were in excellent health and more likely represent individuals who are "optimally" or "successfully" aging. Clearly, this analysis utilized cross-sectional data and needs be interpreted with some caution. Unfortunately, longitudinal data addressing this issue does not currently exist. It is interesting that a very recent study found that healthy older adults have reduced daytime sleep propensity and reduced total sleep compared to healthy younger adults, although the study could not distinguish whether this was the result of decreased sleep ability or decreased sleep "need" (Klerman & Dijk, 2008).

What the findings of Ohayon et al. (2004) demonstrate is that when the comorbidities that typically accompany the aging process are controlled for and optimal aging examined, then the bulk of age-related sleep changes are found to occur by middle adulthood and that, after age 60, assuming one remains in good health, further age-related sleep changes are, at most, modest. Conversely, if comorbidities are present, then age-related sleep changes may well be exacerbated.

CIRCADIAN RHYTHM CHANGES IN NORMAL AGING

Not only does the quality of sleep change across the human life span, as described above, but the timing of sleep also changes. Circadian rhythms are those that occur within a period of 24 hours (from the Greek *circa-*, "about," and *dies*, "a day"), such as the adult human sleep/wake cycle. The impact of aging on human circadian rhythms has been comprehensively reviewed by Monk (2005). Interestingly, as with sleep, there is a considerably disparity between the conventional wisdom concerning circadian rhythms and aging and the evidence supporting, or not supporting, those conventionally held beliefs. Monk summaries the conventional wisdom as: (a) circadian amplitude (peak-to-trough) is reduced; (b) there is a circadian phase advance (the circadian rhythm moves earlier relative to the environment); (c) there is a shortening of the circadian free-running period (called "tau," the actual period of the rhythm, which only approximates 24 hours); and (d) the ability to tolerate rapid phase shifts (such as shift work or jet lag) declines (Monk, 2005). However, the available evidence convincingly supports only two of these assumptions: that older people tend to have earlier circadian phases—tending to both go to and arise from bed somewhat earlier than younger adults—and that they have more trouble than younger adults adjusting to the rapid phase shifts of shift work and jet lag, at least in terms of sleep quality, subjective complaint, and performance measures. The data supporting

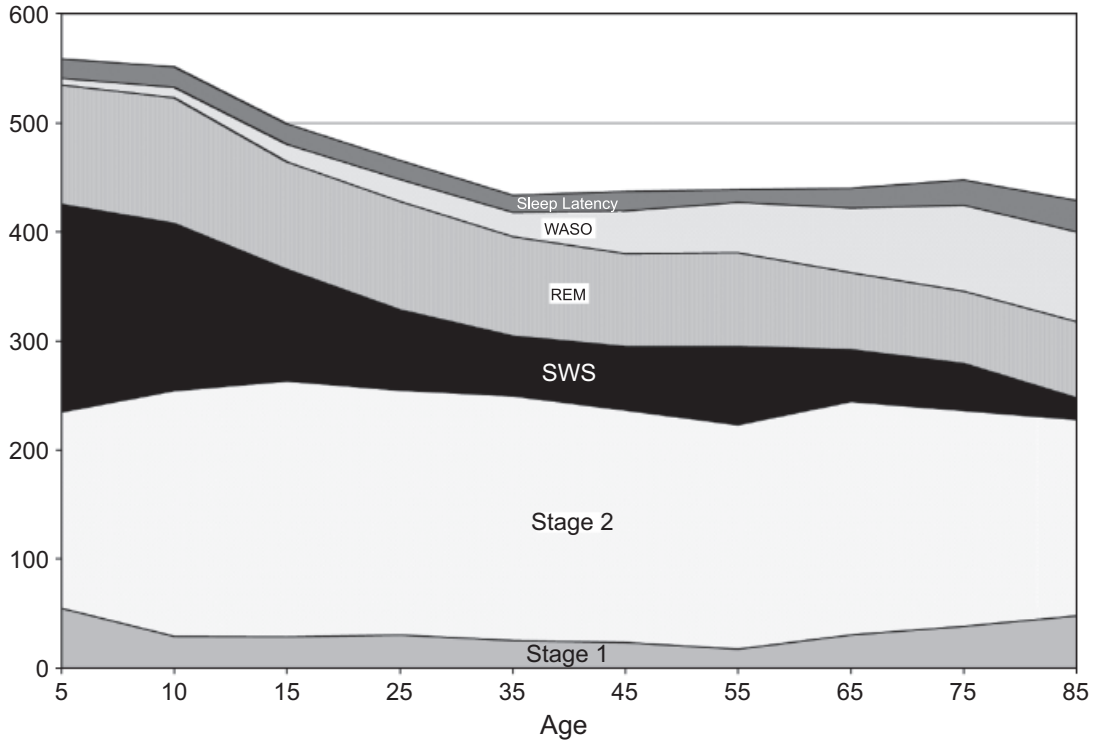

Fig. 1. Age-related trends for nighttime Stage 1 sleep, Stage 2 sleep, slow-wave sleep (SWS), rapid eye movement (REM) sleep, wake after sleep onset (WASO) and sleep latency (time to fall asleep) in minutes. Reproduced from ''Meta-Analysis of Quantitative Sleep Parameters From Childhood to Old Age in Healthy Individuals: Developing Normative Sleep Values Across the Human Lifespan,'' by M.M. Ohayon, M.A. Carskadon, C. Guilleminault, & M.V. Vitiello, 2004, *Sleep*, *27*, p. 1270. Copyright 2004, Sleep Research Society. Reproduced with permission.

diminished circadian amplitudes and shortened circadian taus in healthy older adults are, at best, equivocal (Monk, 2005).

NAPPING AND EXCESSIVE DAYTIME SLEEPINESS IN NORMAL AGING

Two other commonly held assumptions about sleep and aging are that older adults typically nap more than younger adults and that they report more excessive daytime sleepiness (EDS). Few epidemiological studies have reported the prevalence of regular napping and its association with sleep complaints and other mental and physical health problems, especially in relation EDS (Ohayon, 2002). Regular napping does increase with advancing age; however, EDS does not (e.g., Young, 2004). As with nighttime sleep disturbance, the likelihood of an older adult to report regular napping or EDS greatly increases in the presence of comorbidities such as medical illness or depression (Foley et al., 2007).

There is also considerable debate as to whether regular napping among older adults, particularly those in good health, may be beneficial to daytime wakefulness or perhaps detrimental to their nighttime sleep propensity, such that daytime napping would result in poorer nighttime sleep. The two studies that examined the impact of daytime napping on the nighttime sleep quality of healthy older adults found that napping had only a mild to moderate negative impact on nighttime sleep quality (e.g., Campbell, Murphy, & Stauble, 2005). However, these results need to be interpreted with caution, as it must be emphasized that the subjects involved were healthy older adults without significant sleep complaints. It remains unclear if similar results would be obtained with a sample of older insomniacs.

CAUSES OF DISTURBED SLEEP IN OLDER ADULTS

Epidemiological studies report that as much as 40 to 50% of older adults complain of significant, chronic sleep disturbance. However, it is important to keep in mind that 50 to 60% of older adults do not. Ohayon et al. (2004) reported that the bulk of age-related sleep changes occur in early to middle adulthood and that the sleep of healthy older adults changes only very slowly across the later human life span. Nevertheless, even healthy older adults who do not complain of any sleep problems have objective sleep quality that has changed compared to younger adults without sleep complaints (Vitiello, Larsen, & Moe, 2004), although the observations of Ohayon et al. (2004) suggest that if these older adults remain healthy they can expect their sleep quality to remain relatively stable. It appears that many healthy, high-functioning older adults, despite having significantly disturbed objective sleep quality compared to healthy younger

adults, adapt their perception of what is "acceptable" sleep and therefore do not complain (Vitiello et al., 2004).

There are many factors over and above age-related homeostatic and circadian sleep changes that can and do contribute to the chronic and significant sleep disturbance reported by nearly half of all older adults. These can include: (a) medical and psychiatric comorbidities and their treatments, such as cardiovascular disease, arthritis, gastro-esophageal reflux, nocturia or depression and many of the drugs used to treat them; (b) primary sleep disorders, many of which tend to occur with increasing frequency in older adults, such as obstructive sleep apnea, restless legs syndrome, and REM behavior disorder; (c) all of the many behavioral, environmental, and social factors, often collectively referred to as sleep hygiene, that can maximize or compromise an individual's sleep quality; or (d) some combination of these factors (Vitiello, 2007; Vitiello, Moe, & Prinz, 2002; Vitiello, 2000).

When medical or psychiatric comorbidities are present, it is clear that normal age-related sleep disruption is exacerbated and that sleep may become problematic (Ohayon et al., 2004). It is important to recognize, however, that such sleep disturbance in the presence of comorbid disease is not necessarily simply a symptom of the comorbid condition, but that it can frequently represent a problem worthy of direct treatment in its own right (Stepanski & Rybarczyk, 2006).

While sleep disturbances can have profound implications for an individual's health, the nature of these disruptions is complex. It must be kept in mind that the sleep disturbances an older individual experiences can be remarkably situation specific. For example, the sleep disturbances of community-dwelling older adults, even if they are aging optimally or "normally," are likely different from older adults in an acute hospital setting; from older adults in long-term-care facilities; and from the many older adults in in such facilities who, because of a dementing disorder, can neither describe their symptoms nor engage as actively in treatment.

TREATING SLEEP DISTURBANCES IN OLDER ADULTS

Just as our understanding of the causes of sleep disruption in older adults has greatly improved, recent years have also brought more effective treatments for these sleep disturbances. Primary sleep disorders such as obstructive sleep apnea, restless legs syndrome, and REM behavior disorder can now effectively be treated (Vitiello, 2000). Particularly promising advances have recently occurred in the cognitive-behavioral treatment of insomnia in older adults.

The now classic study of Morin and colleagues (Morin, Colecchi, Stone, Sood, & Brink, 1999) was an elegant demonstration of the immediate and, in particular, long-term efficacy of cognitive-behavioral therapy (CBT) treatment of chronic primary insomnia in older adults. The principal active components of CBT in the treatment of insomnia are stimulus-control therapy, which replaces learned negative responses to the bedroom environment with positive ones; and sleep (bedtime) restriction therapy, which maximizes the homeostatic drive for sleep. Morin's classic demonstration of CBT's efficacy in older insomniacs has been replicated and expanded by studies which again contradict common wisdom—this time, the commonly held assumption that if insomnia existed along with another medical or psychiatric illness, it was simply a secondary symptom to the primary disorder, and that effectively treating the comorbid disorder would improve the insomnia.

These recent studies include demonstrations that CBT can improve the sleep of older insomniacs who have comorbid medical illnesses such as osteoarthritis, chronic obstructive pulmonary disease, cardiovascular disease (Rybarczyk et al., 2005), and Alzheimer's disease (McCurry, Gibbons, Logsdon, Vitiello, & Teri, 2005). A very recent preliminary study has demonstrated that CBT for insomnia not only improves sleep quality but also reduces immediate and long-term pain in older adults with comorbid insomnia and osteoarthritis, suggesting that disturbed sleep is not simply a symptom of the pain syndrome and that improving sleep may well improve aspects of the comorbid illness (Vitiello, Rybarczyk, Von Korff, & Stepanski, 2009).

CONCLUSION

In 2006, the Institute of Medicine of the National Academy of Sciences released the report, *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem* (Institute of Medicine, 2006), recognizing that sleep disorders and sleep deprivation are significant public health problems and calling for increased awareness among healthcare professionals and the development and implementation of effective treatments for sleep disorders.

We are gaining a better understanding of the causes and consequences of and effective treatments for disturbed sleep in older adults. Several large prospective epidemiological studies that will provide us with better understanding of how sleep changes in both optimal and normal aging are currently underway. Experimental studies will continue to explicate the interactions of aging with homeostatic and circadian sleep mechanisms, including their underlying genetic bases. Particularly exciting is the rapid progress being made on use of CBT to improve sleep in older adults. One such line of research focuses on developing efficacious CBT treatments of shorter duration than the six to eight session protocols that have been standard in the treatment of insomnia. A second line of research is beginning to demonstrate the efficacy of CBT for treatment of insomnia in older adults with comorbid illnesses that will not only demonstrate that this therapy improves sleep but that improved sleep may result in decreased pain, decreased depression, and perhaps even improvement in cardiovascular or metabolic health. Anticipated advances like these will help ensure that growing older not does not mean sleeping poorly and that sleeping well can truly improve overall health.

Recommended Readings

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Cajochen, C., Münch, M., Knoblauch, V., Blatter, K., & Wirz-Justice, A. (2006). Age-related changes in the circadian and homeostatic regulation of human sleep. *Chronobiology International*, *23*, 461–474. A state-of-the-art review paper examining what is known about age-related changes in the circadian and homeostatic mechanisms that regulate sleep.

Dijk, D.J., Duffy, J.F., & Czeisler, C.A. (2001). Age-related increase in awakenings: Impaired consolidation of nonREM sleep at all circadian phases. *Sleep*, *24*, 565–577. A classic paper which uses experimentally forced desynchrony between the sleep/wake cycle and circadian rhythms to examine the circadian and sleep-dependent regulation of the frequency and duration of awakenings in younger and older people.

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