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Preface: Sleep Medicine: Its Imperfect Past **xiii**

Ana C. Krieger and Teofilo Lee-Chiong Jr.

Sleep, Health, and Society **117**

Michael A. Grandner

Insufficient sleep and sleep disorders are highly prevalent in the population and are associated with significant morbidity and mortality. Adverse outcomes of insufficient sleep and/or sleep disorders are weight gain and obesity, cardiovascular disease, diabetes, accidents and injuries, stress, pain, neurocognitive dysfunction, psychiatric symptoms, and mortality. Exposure to sleep difficulties varies by age, sex, race/ethnicity, and socioeconomic status; significant sleep health disparities exist in the population. Societal influences, such as globalization, technology, and public policy, affect sleep at a population level.

Neurobiology of Circadian Rhythm Regulation **141**

Alan M. Rosenwasser and Fred W. Turek

In this review, we provide a summary of the field of mammalian circadian neurobiology circa 2015. While many additional details have emerged in the intervening seven years, understanding of the fundamental structure and function of this critical neural system remains intact. Thus, the present review continues to provide a valuable introduction for those seeking an integrative multilevel overview of the circadian system. In brief, the circadian system comprises a coupled network of molecular/cellular- and tissue-level oscillators, hierarchically coordinated by the hypothalamic suprachiasmatic nuclear circadian pacemaker, and entrained by both photic and nonphotic signals.

Sleep-Wake Neurochemistry **151**

Sebastian C. Holst and Hans-Peter Landolt

Behavioral states naturally alternate between wakefulness and the sleep phases rapid eye movement and nonrapid eye movement sleep. Waking and sleep states are complex processes that are elegantly orchestrated by spatially fine-tuned neurochemical changes of neurotransmitters and neuromodulators including glutamate, acetylcholine, γ -aminobutyric acid, norepinephrine, dopamine, serotonin, histamine, hypocretin, melanin concentrating hormone, adenosine, and melatonin. However, as highlighted in this brief overview, no single neurotransmitter or neuromodulator, but rather their complex interactions within organized neuronal ensembles, regulate waking and sleep states. The neurochemical pathways presented here are aimed to provide a conceptual framework for the understanding of the effects of currently used sleep medications.

Sleep in Normal Aging **161**

Junxin Li, Michael V. Vitiello, and Nalaka S. Gooneratne

Sleep is a key determinant of healthy and cognitive aging. Sleep patterns change with aging, independent of other factors, and include advanced sleep timing, shortened nocturnal sleep duration, increased frequency of daytime naps, increased number of nocturnal awakenings and time spent awake during the night, and decreased slow-wave sleep. The sleep-related hormone secretion changes with

aging. Most changes seem to occur between young and middle adulthood; sleep parameters remain largely unchanged among healthy older adults. The circadian system and sleep homeostatic mechanisms become less robust with normal aging. The causes of sleep disturbances in older adults are multifactorial.

Epidemiology of Insomnia: Prevalence, Course, Risk Factors, and Public Health Burden 173

Charles M. Morin and Denise C. Jarrin

This article summarizes epidemiologic evidence on insomnia, including the prevalence, incidence, and risk factors, as well as its course and consequences. Approximately 10% of the adult population suffers from an insomnia disorder and another 20% experiences occasional insomnia symptoms. Women, older adults, and people with socioeconomic hardship are more vulnerable to insomnia. Insomnia is often a chronic condition, with a 40% persistence rate over a 5-year period. Insomnia is a significant public health problem that should be addressed at the individual level with appropriate clinical care and at the population level with large-scale sleep health interventions.

The Effects of Insomnia and Sleep Loss on Cardiovascular Disease 193

Meena S. Khan and Rita Aouad

Sleep loss has negative impacts on quality of life, mood, cognitive function and health. Insomnia or difficulty sleeping is also a prevalent issue, affecting up to 35% of the population at some point in their lives. Insomnia is linked to poor mood, increased use of health care resources, and decreased quality of life as well as possible links to cardiovascular risk factors and disease. Studies have shown an increase in cortisol levels, decreased immunity, and increased markers of sympathetic activity in sleep-deprived healthy subjects and those with chronic insomnia. The literature also shows that subjective complaints consistent with chronic insomnia and shortened sleep time, both independently and in combination, can be associated with the development of diabetes, hypertension, and cardiovascular disease. In this article, we will explore the relationship and strength of association between insufficient sleep and insomnia with these health conditions.

Sleep and Cognition: A Narrative Review Focused on Older Adults 205

Joseph M. Dzierzewski, Elliottneil Perez, Scott G. Ravyts, and Natalie Dautovich

Little is known regarding sleep's association with the traditional developmental course of late-life cognitive functioning. As the number of older adults increases worldwide, an enhanced understanding of age-related changes in sleep and cognition is necessary to slow decline and promote optimal aging. This review synthesizes the extant literature on sleep and cognitive function in healthy older adults, older adults with insomnia, and older adults with sleep apnea, incorporating information on the potential promising effects of treating poor sleep on cognitive outcomes in older adults. Unifying theories of the sleep-cognition association, possible mechanisms of action, and important unanswered questions are identified.

Sleep in Hospitalized Older Adults 223

Nancy H. Stewart and Vineet M. Arora

Hospitalization is a period of acute sleep deprivation for older adults due to environmental, medical, and patient factors. Although hospitalized patients are in need of adequate rest and recovery during acute illness, older patients face unique risks due to acute sleep loss during hospitalization. Sleep loss in the hospital is

associated with worse health outcomes, including; cardio-metabolic derangements and increased risk of delirium. Because older patients are at risk of; polypharmacy and medication side effects, a variety of nonpharmacological interventions are recommended first to improve sleep loss for hospitalized older adults.

Insomnia in the Older Adult

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Glenna S. Brewster, Barbara Riegel, and Philip R. Gehrman

Although insomnia is not a normal part of the aging process, its prevalence increases with age. Factors such as medications, and medical and psychiatric disorders can increase the risk for insomnia. In order to diagnose insomnia, it is important for older adults to complete comprehensive sleep and health histories. Cognitive behavioral therapy for insomnia, which includes stimulus control, sleep restriction, sleep hygiene, and cognitive therapy, is the recommended first-line treatment of insomnia and is more effective than medications for the long-term management of insomnia. Medications such as benzodiazepines and antidepressants should be avoided for the treatment of insomnia in older adults.

Circadian Rhythm Sleep–Wake Disorders in Older Adults

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Jee Hyun Kim, Alexandria R. Elkhadem, and Jeanne F. Duffy

The timing, duration, and consolidation of sleep result from the interaction of the circadian timing system with a sleep–wake homeostatic process. When aligned and functioning optimally, this allows for wakefulness throughout the day and a long consolidated sleep episode at night. Changes to either of the sleep regulatory processes or how they interact can result in an inability to fall asleep at the desired time, difficulty remaining asleep, waking too early, and/or difficulty remaining awake throughout the day. This mismatch between the desired timing of sleep and the ability to fall asleep and remain asleep is a hallmark of a class of sleep disorders called the circadian rhythm sleep–wake disorders. In this updated article, we discuss typical changes in the circadian regulation of sleep with aging; how age influences the prevalence, diagnosis, and treatment of circadian rhythm sleep disorders; and how neurologic diseases in older patient impact circadian rhythms and sleep.

Sleep Deprivation and Circadian Disruption Stress, Allostasis, and Allostatic Load

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Bruce S. McEwen and Ilia N. Karatsoreos

Getting a good night's sleep seems a panacea for improving mood and cognition. These subjective impressions are supported by countless studies exploring the impacts of sleep (and sleep loss) on mental health, metabolism, and immune function. Similarly, being “out of phase” with local time, commonly experienced by shift workers of jet-lagged air travelers, demonstrates that there are both neural and physiologic effects of internal circadian (daily) time being misaligned with external environmental time. This article reviews these areas contextualized using the model of allostasis and allostatic load emphasizing the impact of this “wear and tear” on the brain and body.

Sleep and Athletic Performance: Impacts on Physical Performance, Mental Performance, Injury Risk and Recovery, and Mental Health: An Update

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Jonathan Charest and Michael A. Grandner

Sleep health is an important consideration for athletic performance. Athletes are at high risk of insufficient sleep duration, poor sleep quality, daytime sleepiness and fatigue, suboptimal sleep schedules, irregular sleep schedules, and sleep and circadian disorders. These issues likely have an impact on athletic performance via several domains. Sleep loss and/or poor sleep quality can impair muscular strength,

speed, and other aspects of physical performance. Sleep issues can also increase risk of concussions and other injuries and impair recovery after injury. Cognitive performance is also impacted in several domains, including vigilance, learning and memory, decision making, and creativity.

Menstrual Cycle Effects on Sleep

283

Fiona C. Baker and Kathryn Aldrich Lee

Sleep and circadian rhythms are altered in association with the hormonal changes in the menstrual cycle and in the presence of menstrual-associated disorders. The magnitude of the effect varies, particularly for self-reported sleep quality, which worsens in some, but not all, women when premenstrual symptoms emerge. Importantly, women with polycystic ovary syndrome (PCOS) have an increased risk for sleep-disordered breathing (SDB), which should be treated to mitigate health impacts. Potential menstrual cycle variability in sleep quality, as well as upper airway resistance, should be considered when evaluating reproductive-age women. For research purposes, the impact of the menstrual cycle phase should be kept in mind when data are collected and, ideally, the phase should be documented. When comparing women with men, women of reproductive age should be studied in the early-mid follicular phase before there is potential influence from ovarian hormones.

Parasomnias and Sleep-Related Movement Disorders in Older Adults

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Alex Iranzo

Sleep paralysis is rare in the elderly but may occur particularly in families suffering from this phenomenon. In a minority of patients with disorders of arousal, the episodes persist until the age of 70. Zolpidem and other medications may induce sleepwalking and sleep eating-related syndrome. Most patients with idiopathic REM sleep behavior disorder (RBD) eventually develop Parkinson disease and dementia with Lewy bodies. Anti-IgLON5 disease includes abnormal behaviors in both non-rapid eye movement sleep and rapid eye movement sleep (REM) sleep. Restless legs syndrome prevalence increases with age until the sixth decade. A severe form of periodic limb movements in sleep may clinically mimic REM sleep behavior disorder (RBD).

Neurodegenerative Disorders and Sleep

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Raman K. Malhotra

Patients suffering from neurodegenerative conditions frequently report sleep complaints, such as insomnia and excessive daytime sleepiness. These symptoms are likely multifactorial, caused by their underlying neurologic disorder and also by medications and other comorbidities associated with the progressive condition. A detailed history, sleep logs, actigraphy, or polysomnography may be necessary to properly diagnosis and manage these patients. Improvement in sleep may result in improvement in neurologic symptoms and quality of life in this population. There is growing evidence that disrupted sleep may lead to acceleration in the progression of the neurodegenerative disorder and may play a role in the pathogenesis.