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MEDICAL EDUCATION: PEER-REVIEWED ARTICLE

Neuroscience at the Core of a Sound Sleep Health Curriculum

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Abstract

Neuroscience should be at the core of a sound sleep health curriculum, especially in early classroom-based medical education. This article canvasses ways in which sleep medicine has been rapidly transformed by tele-sleep tools and by research on neurobiological mechanisms underlying sleep disorders and on comorbidities associated with sleep disorders, including stroke, traumatic brain injury, and movement or neurocognitive disorders.

Evaluating Sleep Medicine Curricula

Within the collective human experience, the sleep-wake cycle is a powerful force dictating the rhythm of our lives. When sleep disruptions occur, the impacts are far-reaching and can contribute to a variety of health consequences, including increased risk of cardiovascular disease, metabolic dysregulation, and psychosocial stress.[1] Sleep difficulties are ubiquitous, with 14.5% of American adults in the 2020 National Health Interview Survey reporting trouble falling asleep on most or all nights within a given month.[2] The complexity of sleep's relationship to all aspects of a person's life has led to the development of the concept of "somnomics" as part of the precision medicine toolbox,[3] which also houses genomics, proteomics, and personomics.[4]

Considering that all clinicians and clinicians-in-training have an informal curricular understanding of sleep medicine through their own experiences with sleep deprivation, it is a shame that the field is yet untethered to and limited within the formal medical curriculum.

Sleep medicine is interdisciplinary, with residency program applicants from fields as diverse as neurology, psychiatry, pulmonology, internal medicine, family medicine, pediatrics, otolaryngology, and anesthesiology. While this multitude of perspectives is celebrated and aids in the plasticity of the sleep field, more discussion needs to occur regarding how national sleep education should be introduced, organized, and championed to ensure that all future clinicians have effective, evidence-based sleep practices. We suggest here that neuroscience should be at the core of a sound sleep health curriculum and that medical school is the prime stage to lay the introductory groundwork.

Neurobiology of Sleep

Sleep medicine training and clinical practice have rapidly transformed over the past decades in tandem with the elucidation of neurobiological mechanisms influencing sleep. The identification of the first Drosophila clock gene period in the 1980s, along with the subsequent discovery of genes and proteins on the endogenous transcription-translation feedback loop, led to the characterization of the oscillatory 24-hour circadian rhythm primarily dictated by the suprachiasmatic nucleus.[5] A wealth of research has been conducted over the years to explore the pathophysiology behind a variety of sleep disorders. Much of the work elucidating the mechanism behind narcolepsy took place in the 1970s in the first US sleep clinic, established as a narcolepsy clinic at Stanford University in 1964.[6] Researchers have recently identified the degeneration of orexin-producing neurons in the lateral hypothalamus as contributing to dysregulated rapid eye movement (REM) sleep architecture, with frequent REM sleep transitions seen in patients with narcolepsy.[7,8] Research on insomnia has yielded mixed evidence in support of the theory that the dysregulation of endogenous wake-promoting/sleep-suppressing molecules leads to the overarching hyperarousal observed in this disorder.[9] The 2022 Accreditation Council for Graduate Medical Education (ACGME) guidelines require that sleep fellows demonstrate knowledge of neurologic mechanisms governing sleep and wakefulness, and ACGME-approved revisions for 2024 include the neurologic pathophysiology related to sleep disorders.[10,11]

Sleep Disorders Among Neurology Patients

Within neurology clinical practice, many patients with stroke, traumatic brain injuries (TBI), movement disorders, and neurocognitive disorders have concurrent sleep disorders as an accompanying process or as a direct result of their disorders. A recent meta-analysis of 64 000 patients with a history of strokes or transient ischemic attacks (TIA) noted that there was a higher prevalence of sleep disordered breathing, obstructive sleep apnea (OSA), insomnia, periodic limb movement disorder, and restless legs syndrome in these patient populations compared to the general population.[12] In fact, due to sleep disorders' association with poor outcomes for patients with cerebrovascular disease and their potential contribution to recurrence of stroke or TIA, the American Heart Association and the American Stroke Association have released guidelines encouraging clinicians to consider sleep studies for patients who have had strokes in order to try to mitigate risk factors.[13] With sleep apnea seen in around half to three-quarters of patients with stroke or TIA,[13] being proactive with this workup can be very fruitful. A meta-analysis of sleep disturbances in patients with TBI found that 50% of the study population developed sleep disturbances, including insomnia, posttraumatic hypersomnia, nightmares, OSA, and narcolepsy.[14] Sleep disorders are thus rampant within neurology clinical practice.

A Neuroscience Basis

Considering the neurobiological roots of sleep and sleep disorders, as well as the complicated relationship between neurological and sleep disorders, it is important to present sleep content to trainees through a neurological lens. OSA is hugely underdiagnosed and undertreated in the stroke patient population. While OSA already has a high prevalence in the general population, with estimates of 34% for men and 17% of women in the United States having OSA,[15] a recent meta-analysis estimated that the prevalence of OSA in patients with stroke and TIA is even higher—around 71%.[16] Nevertheless, a recent cross-sectional study found that only around 2.2% of stroke patients ultimately obtained polysomnography tests for OSA diagnosis.[17] Taking into consideration that an estimated 690 000 people suffer strokes every year,[13] OSA is

vastly underdiagnosed in a very vulnerable patient population. Given that sleep apnea is associated with higher risk of future cerebrovascular events, higher mortality, depressed mood, and worse functional status in patients with strokes and TIA,[13] it is critically important to encourage physician education on addressing and treating sleep disorders within this population. Moreover, some clinical trials have demonstrated that early continuous positive airway pressure device use following stroke leads to improved stroke outcomes, functional status, and National Institutes of Health stroke scores.[18,19]

While certain neurological disorders can cause the subsequent development of sleep disorders, there are situations in which sleep disorders can be a harbinger of neurological disorders to come. REM sleep behavior disorder (RBD) is strongly associated with the development of future neurodegenerative disorders, as roughly 80% of patients diagnosed with isolated RBD develop Parkinson's disease, Lewy body dementia, or multiple system atrophy within the following 10 years.[20] Being well-informed regarding these relationships can ensure careful monitoring within the RBD patient population. For patients with Alzheimer's disease, insomnia is very common and is associated with worsened clinical outcomes, increased caregiver burden, and increased health care utilization.[21] A potentially bidirectional relationship between disordered sleep and dementia has additionally been suggested,[22] with studies demonstrating that sleep fragmentation is associated with incidence of Alzheimer's disease and rate of cognitive decline.[23] Further research is necessary to elucidate the neurobiological bases of this sleep disorder and potential future treatments. With the overall direct health care costs of sleep disorders in the United States being close to $94.9 billion annually, there is a great need for the thoughtful organization and promotion of a standardized sleep curriculum to ensure effective sleep practices.[24]

Neurologically Based Sleep Medicine Curriculum

Housing a standardized sleep medicine curriculum within the medical school neurology clerkship can maximize the number of medical trainees exposed to effective sleep practices and allow them to benefit from early practice under the guidance of neurology educators. Currently, opportunities for sleep medicine exposure in medical schools are still limited. A 2011 survey of sleep medicine education in 12 countries found that the average amount of time spent on sleep education was around 2.5 hours, with 27% of responding medical schools reporting that their school did not provide sleep education and the mean and median time spent on sleep education in the United States and Canada being around 3 hours.[25] Comparatively, a 2020 cross-sectional survey of medical schools in the United Kingdom found that the average amount of time spent on undergraduate sleep education was 3.2 hours, with the median being 1.5 hours.[26] Although residency programs throughout the United States offer opportunities to study sleep medicine, with the highest percentages reported being 90.8% of neurology residency programs and 85.7% pulmonary and critical care programs, less than 10% of programs produce fellows over 5 years and even fewer students pursue funding for sleep-related research.[27] There is clearly a great need to promote sleep education within medical schools. Neurology educators have previously established national objectives for neurology clinical experiences that include sleep medicine education in the undergraduate medical curriculum,[28,29] and *Neurology* has published on the need for sleep medicine as a core competency within the neurology clerkship.[30,31]

By entrusting neuroscience courses and neurology clinical experiences (eg, clerkships) with implementing a standardized sleep curriculum, educators can ensure that medical students are exposed to good sleep medicine practices throughout the different phases

of their training and encourage increased sleep fellowship interest. Moving forward, it will be important to build flexibility into the curricular content to accommodate various medical school environments and resource availability. Potential venues for curriculum development include flipped classrooms during the preclinical curriculum and tele-sleep opportunities during the neurology clerkship.[31] A large meta-analysis of academic outcomes in flipped classrooms demonstrated better exam scores and course grades than lecture-based classrooms,[32] and other studies have shown improved student satisfaction with flipped classrooms.[33] Within the clinical years, tele-sleep opportunities can be incorporated to allow students to assess the sleep environment and speak with patients' family members who witness sleep pathology. Tele-sleep opportunities additionally allow students to engage with more patients with neurological disorders that hinder clinic visits. At the same time, these virtual opportunities can allay concerns of overburdening the current preclinical and clinical medical school schedules by allowing students to engage in clinical visits from home. Such virtual opportunities will decrease student transportation time and decrease stressors by creating a more relaxed setting, allowing students to access educational material in real time during the clinical experience without causing disruptions. There are also mobile apps, such as MySleep101, which enable nonspecialists to provide sleep information to patients and allow patients to develop questions at home to address in clinic in order to make counseling more efficient.[34] Virtual opportunities can also increase inclusion of a variety of student populations interested in medicine. For example, at Johns Hopkins University, there are tele-sleep shadowing opportunities available to premed students through participation in the PreDoc program.[35] More recently, opportunities to do tele-sleep clinical electives have also been extended to neurology residents in other medical programs who are interested in sleep medicine but do not have opportunities for exposure to this field at their schools.

Conclusion

Neuroscience and sleep medicine are intricately interwoven, as evidenced by both the neurobiological mechanisms dictating sleep disorders and the high prevalence of sleep comorbidities within the neurology patient population. Encouraging neurology educators to step up to champion a nationwide sleep curriculum early in medical school will ensure that the good practices learned today will remain good practices employed tomorrow.

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