

Incorporating sleep medicine content into medical school through neuroscience core curricula

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Abstract

Objective

To present (1) justification for earmarking sleep medicine education as an essential component of all medical school curricula and (2) various avenues to incorporate sleep medicine exposure into medical school curricula through (primarily) neuroscience and neurology courses.

Methods

Per consensus of a team of leading neurology and sleep medicine educators, an evidence-based rationale for including sleep medicine across a 4-year medical school curriculum is presented along with suggested content, available/vetted resources, and formats for delivering sleep medicine education at various points and through various formats.

Results

Growing evidence has linked sleep disorders (e.g., sleep-disordered breathing, chronic insufficient sleep) as risk factors for several neurologic disorders. Medical educators in neurology/neuroscience are now strongly advocating for sleep medicine education in the context of neurology/neuroscience pre and post graduate medical education. Sleep medicine education is also a critical component of a proactive strategy to address physician wellness and burnout. The suggested curriculum proposes a sleep educational exposure time of 2–4 hours per year in the form of lectures, flipped-classroom sessions, clinical opportunities, and online educational tools that would result in a 200%–400% increase in the amount of sleep medicine exposure that US medical schools currently provide. The guidelines are accompanied by the recommendation for use of technological education, to facilitate more seamless curricular incorporation.

Conclusion

Even in this era with limited flexibility to add content to an already packed medical school curriculum, incorporating sleep medicine exposure into the current medical school curriculum is both justified and feasible.

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Glossary

AAN = American Academy of Neurology; AASM = American Academy of Sleep Medicine; LCME = Liaison Committee on Medical Education; RITE = Residency In-Service Training Examinations.

Sleep medicine crosses all domains of medicine. All future physicians, no matter their specialty, will undoubtedly encounter a patient with disrupted sleep or consequences from a sleep disorder. Sleep health care is so medically ubiquitous that sleep medicine concepts are widely represented across various required standardized medical training examinations (e.g., the US Medical Licensing Examination, the National Board of Medical Examiners shelf examinations, and Residency In-Service Training Examinations [RITE]). We propose recommendations to incorporate sleep medicine content across a medical school curriculum (table 1). Per consensus of a team of leading neurology and sleep medicine educators, suggested content, available/vetted resources, and formats for delivering sleep medicine education at various points and under various educational contexts are presented.

Methods

The suggested curricular elements were developed using the standard, existing frameworks of medical education and specializing them toward sleep medicine. This specialization begins at the basic science level and continues through clinical exposure and even a sleep elective, if desired. Content of sleep medicine topics in a variety of certification examinations were collected and analyzed to assess the level of sleep medical background being provided for physicians in several specialties. A similar process was used to integrate a “genetics track” in the curriculum of Baylor College of Medicine.¹ In keeping with existing recommendations for introducing pain medicine into medical school curricula, these guidelines emphasize an innovative and integrative approach.² Our recommendations are based on the authors’ consensus (that includes educators in neurology and sleep medicine) and balance specific criteria for a well-rounded sleep medicine curriculum while still allowing enough room for interpretation to fit the educational philosophies of a diverse array of medical institutions.

Curricular content development

Following recommended guidelines for curriculum evaluation,³ we performed a systematic review of medical school sleep education. Sources included the American Thoracic Society CORE curriculum: part I: adult sleep medicine,⁴ the American Academy of Neurology Core Curriculum in Sleep Medicine,⁵ and the European catalogue of knowledge and skills for sleep medicine.⁶ Published reports as well as shelf, US medical licensing, residency in-service training, and medical board certification examination guidelines were reviewed (table 2). An interdepartmental focus group of Johns Hopkins sleep experts reviewed the curricular precedents and from these the major topic headings for the report template were

established. Subsequent input on curricular content was sought from sleep medicine experts/coauthors at Wake Forest, Rush, Stanford, Cornell, University of North Carolina, and University of Southern California. Detailed learning objectives, where available, from each of the published sources were reviewed by the group and discussed in the context of the educational needs of medical students, constraints on medical education models, and the multidisciplinary nature of sleep as a specialty.

Part 1: Formal incorporation of sleep medicine content in medical school curricula: Why do we need it and why should neurology spearhead the effort?

Reason 1: Sleep is integral to health, yet sleep disorders remain underrecognized

According to the National Sleep Health Index, 1 in 6 of the surveyed Americans reported that they had been diagnosed with a sleep disorder in the last year.⁷ There are 81 identified sleep disorders divided into 8 categories that apply to various medical specialties.⁸ Sleep medicine has a substantial reach beyond the classical sleep disturbances such as acute insomnia or sleep deprivation. Indeed, sleep-disordered breathing is estimated to affect approximately 15% of the US population.⁹ Sleep disorders typically coexist with many common and chronic medical conditions (e.g., arthritis, diabetes, and obesity) as well as various neurologic conditions and can contribute to the development of hypertension and cardiovascular and cerebrovascular events.

Moreover, mistreatment of sleep problems is posing a public health crisis. For example, in just 2 decades, from 1999 to 2010, there was a greater than 400% increase in the number of outpatient office visits that documented a sleep disorder and a nearly 300% increase in the number of sleep medications prescribed (reflected in an approximately 350% and 430% increase for nonbenzodiazepine sleep medications and benzodiazepine receptor agonists, respectively).¹⁰ Such prescribing habits have continued despite the fact that the American Academy of Sleep Medicine warns against the use of hypnotic medications as primary therapy for chronic insomnia, as evidence suggests cognitive behavioral therapy for insomnia should be first-line therapy.¹¹ Particularly in the elderly population, inappropriate treatment of insomnia has become a concern, given that almost 1 in 10 elderly patients use benzodiazepines,¹² despite the known associations with increased risks of fractures and falls, car crashes, and dementia in this population.^{13,14} Although it is known that members of the elderly population are at increased risk for side effects from sedatives/hypnotics like benzodiazepines, such prescribing

Table 1 Proposed curriculum to incorporate sleep medicine into all levels of medical education

Examination	“Sleep” mentioned in examination-provided content details	Sleep-related content implied ^a	Specialists permitted to sit for sleep fellowship examination (board examinations only)	Citation
Graduate level				
In-service training examinations				
American Academy of Neurology residency in-service training examination	Yes	Yes		American Academy of Neurology; “Overall RITE Blueprint for 2017”; residency in-service training examination; aan.com/tools-and-resources/residents-fellows/residency-in-service-training-examination-rite/
American Board of Pediatrics in-training examination	Yes	Yes		American Board of Pediatrics; “General Pediatrics Content Outline”; in-training examination; abp.org/sites/abp/files/pdf/gp_contentoutline_2017.pdf
Psychiatry resident in-training examination	Yes	Yes		American College of Psychiatrists; “The Psychiatry Resident In-Training Examination (PRITE)”; acpsych.org/prite
American Board of Surgery in-training examination	No	Yes		American Board of Surgery; “General Content Outline for the ABSITE”; absurgery.org/xfer/GS-ITE.pdf
American Board of Internal Medicine in-training examination	No	Yes		American College of Physicians; “IM-ITE FAQs”; aconline.org/featured-products/medical-educator-resources/im-ite/faq
American Board of Family Medicine in-training examination	No	Yes		American Board of Family Medicine; “In-Training Examination Content”; theabfm.org/cert/ite.aspx
Board examinations				
American Board of Psychiatry and Neurology certification examination in neurology	Yes	Yes	Yes	American Board of Psychiatry and Neurology; “Certification Examination in Neurology”; abpn.com/wp-content/uploads/2017/01/2017_Neurology_CERT_Content_Specifications.pdf
American Board of Pediatrics certification examination	Yes	Yes	Yes	American Board of Pediatrics; “General Pediatrics Content Outline”; abp.org/sites/abp/files/pdf/gp_contentoutline_2017.pdf
American Board of Psychiatry and Neurology certification examination in psychiatry	Yes	Yes	Yes	American Board of Psychiatry and Neurology; “Certification Examination in Psychiatry”; abpn.com/wp-content/uploads/2017/01/2017_Psychiatry_CERT_Content_Specifications.pdf
American Board of Surgery certification examination	No	Yes	No	absurgery.org/xfer/GS-QE.pdf
American Board of Internal Medicine certification examination	Yes	Yes	Yes	American Board of Internal Medicine; “Internal Medicine Certification Examination Blueprint”; abim.org/~media/ABIM%20Public/Files/pdf/exam-blueprints/certification/internal-medicine.pdf
American Board of Obstetrics and Gynecology certification examination	No	Yes	No	American Board of Obstetrics and Gynecology; “2018 Bulletin for the Certifying Examination in Obstetrics and Gynecology”; abog.org/bulletins/2018%20Certifying%20Examination%20in%20Obstetrics%20and%20Gynecology.pdf
American Board of Family Medicine certification examination	Yes	Yes	Yes	American Board of Family Medicine; ABFM Certification Exam Content”; theabfm.org/moc/examcontents.aspx

Continued

Table 1 Proposed curriculum to incorporate sleep medicine into all levels of medical education (continued)

Examination	"Sleep" mentioned in examination-provided content details	Sleep-related content implied ^a	Specialists permitted to sit for sleep fellowship examination (board examinations only)	Citation
Undergraduate level				
US Medical Licensing Examination Step 1	Yes	Yes		1. US Medical Licensing Examination; "Content Description and General Information"; usmle.org/pdfs/usmlecontentoutline.pdf

Sleep topics on certification examinations. Each curriculum component is accompanied by the phase of training it would fit best into, the rationale for its inclusion, and an implementation plan.

^a Infers sleep's relevance to an examination based on search terms that are integral to sleep medicine, e.g., "apnea," "REM," "circadian rhythm."

habits are continuing unabated, as it was noted in a recent review that only a third of benzodiazepine prescriptions in this age group were considered appropriate.¹⁵ Such fundamental concerns with our medical system likely reflect failings of appropriate education, which begins at the medical school level.

There is limited formal preclinical and clinical didactic time devoted to sleep medical education, which may be related to the small number of clinicians who choose to specialize in the field. A sleep medicine review of medical textbooks found that sleep and sleep disorders accounted for a disproportionately small percentage of the content.¹⁶ In most medical schools, only 2–4 hours are dedicated to sleep education.¹⁷ With 156.4 didactic weeks in the average 4-year medical curriculum, sleep education only comprises 0.06% of classroom education.¹⁸ While sleep may be included in the curriculum, exposure to this topic during the clinical years is typically limited to discussion related to sleep/wakefulness instability and transition states such as delirium. If future clinicians continue to have limited exposure to the fundamental concepts of sleep medicine education, we run the risk of underrecognizing and thereby undertreating sleep disorders that often negatively affect patients with medical disorders and, more specifically, neurologic disorders.

Reason 2: Sleep is integral to the management of neurologic patients

Medical educators in neurology are now strongly advocating for sleep medicine education in the context of neurology/neuroscience pre and post graduate medical education.⁶ In the 2014 medical school neuroscience curriculum guidelines published in *Neurology*[®], sleep medicine was included as a core competency domain.¹ Many educators have argued that a strong foundation in sleep medicine is critical early in a clinician's education, because understanding sleep is critical to an intellectual grasp of neurobiology. In fact, the most prevalent sleep disorder, sleep apnea, can provide a complementary

platform for understanding brainstem neurophysiology through description of the neurocircuitry that controls the multiple, supportive autonomic functions during sleep. Moreover, growing evidence has linked sleep disorders (e.g., sleep-disordered breathing, chronic insufficient sleep) as primary and secondary risk factors for neurologic disorders such as stroke, epilepsy, and migraine, thereby suggesting a potential to link the preclinical curricular elements to patient care interactions.^{1,19,20}

Other sleep disorders (e.g., chronic insufficient sleep, circadian rhythm sleep–wake disorders, insomnia) have also been recognized as a major cause of morbidity in other common neurologic conditions such as dementia, multiple sclerosis, CNS gliomas, and chronic pain.^{21,22} REM sleep behavior disorder can predate the neurologic symptoms associated with α -synucleinopathies (e.g., Parkinson disease, Lewy body dementia, and multiple system atrophy) by as much as 10 years, suggesting that appropriate recognition of sleep disorders can serve as a potential early biomarker to identify patients with neurodegenerative conditions who may benefit from disease-modifying intervention.²³

Reason 3: Sleep medicine education is a strategy to improve physician wellness and tackle burnout

Evidence suggests that the health behavioral habits of health care professionals influence the quality of their work and trajectory of their careers.²⁴ Thus, initiating early exposure in clinical training can raise sleep health awareness to improve patient care and expose clinicians to the importance of good sleep hygiene for themselves. Moreover, some evidence suggests an association between the sleep habits of clinicians and burnout.^{25–27} The American Academy of Neurology (AAN) recently cited personal health and wellness as an individual provider strategy to mitigate burnout.²⁸ Thus, placing a curricular priority on sleep medicine exposure in medical school would be a proactive strategy to tackle the growing incidence of burnout and stress also being reported in medical students and neurology resident trainees.¹⁷ In fact, the American

Table 2 The presence of sleep medicine topics on certification examination review guides

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
Preclinical years	Sleep and public health	As many as 1 in 6 Americans have a sleep disorder.	Students should understand the public health and safety impact of sleep health and behavior.	Public health seminar	1. Grandner MA, Gallagher RAL, Gooneratne NS. The use of technology at night: impact on sleep and health. <i>J Clin Sleep Med</i> 2013;9:1301–1302.
		Sleep medicine is devoted a disproportionately small percentage of major medical education textbooks.			2. Institute of Medicine. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington, DC: The National Academies Press; 2006.
		Only 2 to 4 hours of instruction time are dedicated to sleep education in the average medical school.			
		Sleep interventions can be used to treat or reduce the risk factors for other chronic diseases. Implementing programs to improve children's sleep quality has been shown to reduce their risk of childhood obesity.			
		A national poll shows a direct correlation between adequate sleep and the reduction of chronic pain. Those with chronic pain reported triple the likelihood of sleep disorder diagnosis than those without pain.			
	Neuroscience of sleep	The neuroscience of sleep has become a prominent motif in social and psychological health research.	Students should understand fundamental neurobiological and chronobiological concepts underlying sleep–wake states, sleep stages, and the impact of sleep deprivation on these states.	Neuroscience preclinical curriculum	1. Spiegelhalter K, Riemann D. Losing sleep. <i>Lancet Neurol</i> 2015;14:571.
		An understanding of the neuroscience of sleep explains why some behaviors are harmful to sleep, such as viewing bright or blue wavelength light at night.			2. Goldstein C, Chervin R. Waking up to sleep research in 2015. <i>Lancet Neurol</i> 2016;15:32.
		The neurophysiology of sleep is used to map the relationship in the neuroscience preclinical curriculum between development and sleep regulation.			3. Zee PC, Badr MS, Kushida C, et al. Strategic opportunities in sleep and circadian research: report of the Joint Task Force of the Sleep Research Society and American Academy of Sleep Medicine. <i>Sleep</i> 2014;37:219–227.

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
		Sleep and REM behaviors have been linked to epigenetic markers that are expressed in the brain.			
	Neuropharmacology of sleep	Tricyclic antidepressants have been shown to have an effect on REM sleep.	Students should understand the neuropharmacology of treatments for sleep-wake disorders. Students will apply the neurobiology of sleep-wake states and sleep neurotransmitters to the neuropharmacology of sleep-wake treatment.	Neuroscience preclinical pharmacology lecture	1. Seema G, Salas R, Gamaldo C. Sleep medicine pharmacotherapeutics overview: today, tomorrow, and the future (part 1: insomnia and circadian rhythm disorders). <i>Chest</i> 2012;142:1659.
		The various pharmacologic treatments of insomnia are a matter of debate because of their relative levels of abuse potential and addictiveness.			2. Seema G, Salas R, Gamaldo C. Sleep medicine pharmacotherapeutics overview: today, tomorrow, and the future (part 2: hypersomnia, parasomnia, and movement disorders). <i>Chest</i> 2013;143:242.
		An understanding of neuropharmacology will teach students the significance of the development of new drugs, e.g., suvorexant for insomnia.			
		The treatment of behavioral disorders with pharmaceuticals is shown to affect sleep.			
		The use of homeopathic pharmaceuticals is a growing trend in sleep medicine.			
Clinical years	Patient history	Performing an examination and especially taking a patient's history are the 2 most effective tools for diagnosing sleep disorders.	Students should recognize aspects of patient history suggesting presence of sleep-wake disorders.	Primary care, neurology core clerkship, or psychiatry core clerkship	1. Shelgikar AV, Chervin R. Approach to and evaluation of sleep disorders. <i>Continuum</i> 2013;19:32-49.
		Students should understand what questions to ask a patient when suspicious of a sleep disorder or when the patient overtly states that a sleeping issue is his or her chief complaint.			
	Patient examination	Performing an examination and especially taking a patient's history are the 2 most effective tools for diagnosing sleep disorders.	Students should recognize aspects of patient examination suggesting presence of sleep-wake disorders.	Primary care, neurology core clerkship, or psychiatry core clerkship	1. Shelgikar AV, Chervin R. Approach to and evaluation of sleep disorders. <i>Continuum</i> 2013;19:32-49.

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
Clinical manifestations		Some sleep disorders, such as sleep-wake disorders and chronic insomnia, are major causes of insomnia in common neurologic diseases such as multiple sclerosis and are underdiagnosed.	Students should understand primary clinical manifestations of common sleep-wake disorders (insomnia, sleep apnea, circadian rhythm sleep-wake disorders, parasomnias, RLS, central hypersomnias).	Primary care, neurology core clerkship, or psychiatry core clerkship	1. Stansbury R, Strollo P. Clinical manifestations of sleep apnea. <i>J Thorac Dis</i> 2015;7:E298-E310.
		The majority of American sleep disorders are undiagnosed, partially because the clinical manifestations of sleep disorders are not emphasized in medical education.			2. Buysse DJ. Insomnia. <i>JAMA</i> 2013;309:706-716.
		In a physician's residency, approximately 17% of the patients he or she sees will have a sleep disorder that may be undiagnosed.			3. Frauscher B, Gabelia D, Mitterling T, et al. Motor events during healthy sleep: a quantitative polysomnographic study. <i>Sleep</i> 2014;37:763-773.
		Many life-threatening or debilitating neurologic conditions have been linked to sleep issues and their treatment.			
		Knowledge of sleep disorders can be helpful in the diagnosis and treatment of movement disorders, such as RLS and periodic limb movement disorder.			
Diagnostics		Some sleep disorders, such as sleep-wake disorders and chronic insomnia, are major causes of insomnia in common neurologic diseases such as multiple sclerosis and are underdiagnosed.	Students should understand the primary indications and role of diagnostic tools for sleep-wake disorders.	Primary care, neurology core clerkship, or psychiatry core clerkship	1. American Academy of Sleep Medicine. Five Things Physicians and Patients Should Question. Choosing Wisely. 2014; choosingwisely.org/aasm-releases-choosing-wisely-list-to-promote-value-based-sleep-care/
		The majority of American sleep disorders are undiagnosed, partially because the clinical manifestations of sleep disorders are not emphasized in medical education.			2. Chirinos JA, Gurubhagavatula I, Teff K, et al. CPAP, weight loss, or both for obstructive sleep apnea. <i>N Engl J Med</i> 2014;370:2265-2275.
		In a physician's residency, approximately 17% of the patients he or she sees will have a sleep disorder that may be undiagnosed.			
		Many life-threatening or debilitating neurologic conditions have been linked to sleep issues and their treatment.			

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
		Knowledge of sleep disorders can be helpful in the diagnosis and treatment of movement disorders, such as RLS and periodic limb movement disorder.			
	Effects of neurologic and psychiatric disorders	Some sleep disorders, such as sleep-wake disorders and chronic insomnia, are major causes of insomnia in common neurologic diseases such as multiple sclerosis and are underdiagnosed.	Students should understand the effects of sleep-wake disorders on the progression and management of neurologic and psychiatric disorders.	Primary care, neurology core clerkship, or psychiatry core clerkship	1. Goldstein AN, Walker MP. The role of sleep in emotional brain function. <i>Ann Rev Clin Psychol</i> 2014;10:679-708.
		The treatment of psychiatric disorders with pharmaceuticals is shown to affect sleep.			2. Gelber R, Redline S, Ross GW, et al. Associations of brain lesions at autopsy with polysomnography features before death. <i>Neurology</i> 2015;84:296.
		A large cohort of Americans are never asked by their physicians about sleep issues.			3. Talbot LS, Maguen S, Metzler TJ, et al. Cognitive behavioral therapy for insomnia in posttraumatic stress disorder: a randomized controlled trial. <i>Sleep</i> 2014;37:327-341.
		Many life-threatening or debilitating neurologic conditions have been linked to sleep issues and their treatment.			4. Littner MR, Kushida C, Wise M, et al. Practice Parameter for clinical use of the Multiple Sleep Latency Test and the Maintenance of Wakefulness Test. <i>Sleep</i> 2005;28:113-121.
		Knowledge of sleep disorders can be helpful in the diagnosis and treatment of movement disorders, such as RLS and periodic limb movement disorder.			
Sleep elective	Effects of neurologic and psychiatric disorder treatment on sleep	Many neurologic conditions have been shown to cause sleep issues and their treatment.	Students should understand the reciprocal relationship of sleep-wake disruption caused by treatment of neurologic and psychiatric disorders.		1. Goldstein AN, Walker MP. The role of sleep in emotional brain function. <i>Ann Rev Clin Psychol</i> 2014;10:679-708.
		Tricyclic antidepressants have been shown to have an effect on REM sleep.			2. Gelber R, Redline S, Ross GW, et al. Associations of brain lesions at autopsy with polysomnography features before death. <i>Neurology</i> 2015;84:296.

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
		The treatment of behavioral disorders with pharmaceuticals is shown to affect sleep.			3. Talbot LS, Maguen S, Metzler TJ, et al. Cognitive behavioral therapy for insomnia in posttraumatic stress disorder: a randomized controlled trial. <i>Sleep</i> 2014;37:327–341.
		In a cross-sectional study of patients in treatment for neurologic disorders, the largest change reported in their quality of life was an increase in sleep disturbance.			
		Even with treatment, acute neurologic injuries can lead to alterations in sleep patterns.			
	Non-neuropharmacology treatments for sleep disorders	The consumption of tart cherry juice is shown to increase melatonin levels in the bloodstream and help treat insomnia.	Students should understand these treatments, such as CBT.		1. Talbot LS, Maguen S, Metzler TJ, et al. Cognitive behavioral therapy for insomnia in posttraumatic stress disorder: a randomized controlled trial. <i>Sleep</i> 2014;37:327–341.
		CBT has been shown to have lasting efficacy for sleep disorders such as insomnia, and CBT is a viable alternative to prescription sleep aids.			2. Gradisar M, Dohnt H, Gardner G, et al. A randomized controlled trial of cognitive-behavior therapy plus bright light therapy for adolescent delayed sleep phase disorder. <i>Sleep</i> 2011;34:1671–1680.
		CBT is effective in reducing dysfunctional beliefs regarding sleep in insomnia patients.			3. Krystal AD, Edinger JD. Sleep EEG response to cognitive behavioral therapy for insomnia. <i>Sleep</i> 2010;33:669–677.
		CBT is shown to outperform sleep aids, such as Ambien, in patients' sleep quality.			
		Physicians should be aware of and able to advise patients on arising technological interventions intended to treat sleep disorders, such as the newly FDA-approved cerave device for insomnia.			
	Interpreting and applying diagnostic tests	Knowledge of sleep disorders can be helpful in the diagnosis and treatment of movement disorders, such as RLS and periodic limb movement disorder.	Students should understand the essentials of aspects of the interpretation and application of diagnostic testing modalities for sleep-wake disorders.		1. Kushida CA, Nichols DA, Holmes TH, et al. SMART DOCS: A new patient-centered outcomes and coordinated-care management approach for the future practice of sleep medicine. <i>Sleep</i> 2015;38:315–326.

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

		Implementation of curriculum			
Phase	Topic	Rationale	Objective	Potential courses/ curriculum to introduce sleep topic	Resources
		Several methods of diagnosis for sleep disorders, such as the polysomnogram, PAP titration study, Multiple Sleep Latency Test, and Multiple Wakefulness Test, are widely used and should be understood by rising physicians.			2. Gooneratne NS, Vitiello MV. Sleep in older adults: normative changes, sleep disorders, and treatment options. <i>Clin Geriatr Med</i> 2014;30:591–627.
		The majority of American sleep disorders are undiagnosed.			3. Garcia-Borreguero D, Kohnen R, Boothby L, Tzonova D, Larrosa O, Dunkl E. Validation of the Multiple Suggested Immobilization Test: a test for the assessment of severity of restless legs syndrome (Willis-Ekbom disease). <i>Sleep</i> 2013;36:1101–1109.
		In a physician's residency, approximately 17% of the patients he or she sees will have a sleep disorder that may be undiagnosed.			
		Rising physicians should be aware of the rising prevalence of home sleep tests so that they can offer them to patients.			
	When to consult a sleep specialist	There is a variety of sleep professionals who may be appropriate for referral, including a sleep medicine physician, sleep surgeon, dental sleep medicine surgeon, and a behavioral sleep medicine specialist. Rising physicians should know which services are appropriate for their patients.	Students should recognize when a patient's needs require the attention of a sleep medicine specialist.		1. Institute of Medicine. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington, DC: The National Academies Press; 2006.
Miscellaneous	Sleep and health wellness	Physician burnout affects the health and well-being of both physicians and their patients.	Students should receive some education on physician burnout, both formally as part of the sleep medicine curriculum and through the involvement of student groups such as the Student Interest Group in Neurology present on many medical school campuses nationally.		1. Avidan AY. Sleep and fatigue countermeasures for the neurology resident and physician. <i>Continuum</i> 2013;19:204–222.
		Sleep deprivation on surgeons affects the morbidity and mortality rates of their work.			
		Physicians and paramedics occupy the fourth highest spot on a national index of sleep deprivation by profession.			
		Residents are more likely to make medical errors when they are sleep-deprived.			

Continued

Table 2 The presence of sleep medicine topics on certification examination review guides (continued)

Phase	Topic	Implementation of curriculum		Potential courses/ curriculum to introduce sleep topic	Resources
		Rationale	Objective		
		Research shows that there is a need to educate physicians on self-care, including sleep management.			
	Dissemination of sleep health information	In a national poll, only 36% of respondents had an adequate understanding of sleep health.	Sleep disorders are in need of a greater level of public awareness. This dissemination from the medical field can be established through social media, Student Interest Group in Neurology, and other platforms.		1. Institute of Medicine. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington, DC: The National Academies Press; 2006.
		Despite mounting evidence that the use of blue light technology before bed can cause sleep issues, 72% of children aged 6–17 have an electronic device in their bedroom while they sleep.			
		While nearly half of surveyed Americans have problems falling or staying asleep, most do not consult a physician or recognize the potential for a sleep disorder.			
		While approximately 25% of polled Americans report snoring every night, the vast majority of them do not consult a sleep specialist with the concern of obstructive sleep apnea.			
		Sleep medicine does not have the robust presence on social media and the Internet that other areas of medicine do. For instance, while the American Heart Association has 850,000 likes on Facebook, the National Sleep Foundation only has 15,000. This disparity in online awareness might affect the perception of sleep disorders as an important public health problem.			
		Sleep medical information can be disseminated to medical students and clinicians who wish to further their learning with the use of clinical sleep apps. Some examples of such apps have been developed by the AAN and the AASM.			

Abbreviations: AAN = American Academy of Neurology; AASM = American Academy of Sleep Medicine; CBT = cognitive-behavioral therapy; RLS = restless legs syndrome. Proposed medical school sleep curriculum reference table. Content was analyzed from the guidelines of several in-service training examinations, board examinations, and the United States Medical Licensing Examination (Step 1).

Association of Medical Colleges has included questions on the national graduation questionnaire regarding student satisfaction with school programs and activities that promote effective stress management, a balanced lifestyle, and overall well-being. Although no specific questions regarding sleep are included in the questionnaire, sleep is likely intertwined with wellness and life balance. Further, the Liaison Committee on Medical Education (LCME), the national accrediting body for US medical schools, also requires that schools have wellness programs and policies to monitor student workload and duty hours, which further supports the need for more sleep health education and awareness. Toward this end, the LCME Accreditation Standards specifically state in section MS-26, “Each school must have an effective system of personal counseling for its students that includes programs to promote the well-being of students and facilitate their adjustment to the physical and emotional demands of medical school.”²⁹ Addressing healthy and disordered sleep in this context can facilitate integration of fundamental sleep physiology and pathophysiology into medical school curricula.

Reason 4: It shows up often on standardized tests

The almost ubiquitous influence of sleep health on both mental and physical function explains its representation as a content topic included across a number of standardized board examinations, subspecialty in-service (e.g., RITE), and specialty board examinations (table 2). Despite a relatively ubiquitous representation on examinations, relatively little time is dedicated to sleep in traditional medical education models, with the average American medical student getting just over 3 hours of exposure to sleep medicine over the course of his or her medical education.³⁰

Part 2: Formal incorporation of sleep medicine content in medical school curriculum: How?

This final section presents recommended pathways for delivery of sleep medicine content across the medical school curriculum along with suggested guidelines for a sleep medicine selective (e.g., optional elective experience) for those students seeking more comprehensive content exposure. The guidelines are accompanied by the recommendation for use of technological education to facilitate more seamless curricular incorporation.

Strategy 1: Consider using neuroscience as an entry point for sleep medicine content

Despite the growing link between sleep disorders and neurologic disease, few guidelines exist regarding sleep medicine curricular content standards and no single specialty has stepped up to champion these efforts. Thus, educators within neurology are critical to the optimal incorporation of sleep medicine into undergraduate medical training. As a collective group of nationally recognized leaders in sleep and medical student education in neurology, we believed that a consensus statement regarding available sleep medicine content resources as well as the paths for delivering the content would be the next logical step to serve the sleep medicine instructional

needs of medical students and neurology and neuroscience curriculum directors. Medical school curricula continue to face intense pressure to include a growing wealth of content in a finite and, in some circumstances, compressed amount of time. As such, recommendations for curricular content must be flexible to take into consideration various medical school structures along with their professional and educational resources.

Strategy 2: Embrace the interdisciplinary nature of sleep in the content incorporation

In addition to its established niche in the domain of neurology, sleep medicine is remarkably interdisciplinary and interprofessional, and thus it is worth highlighting that clinical exposure to sleep can be incorporated within a number of core clerkships, tailored to the curricular structure of the individual institution. This approach aims to offer enough specificity to be immediately applicable while still flexible enough to integrate into existing frameworks. Table 1 provides an approach to inserting critical sleep content in a longitudinal fashion across all years of medical school. The proposed suggestions for sleep curricular content were specifically developed to afford flexibility in the adaptation (based on available medical expertise at the individual institution) and implementation (based on the respective curricular format of the institution).

A breadth of disciplines may be actively involved in the implementation of sleep medicine curricula, and other interprofessional health care experts (e.g., nurse, respiratory therapist, behavioral sleep psychologist, public health expert) can also potentially provide medical educators with a means of targeting sleep-related areas within their curricula that are most conducive to implementation of the proposed standards and content. The field of sleep medicine offers an excellent opportunity for interprofessional collaboration, which is at the core of health care practice today. Provision of interprofessional collaborative skills experience is also a requirement of the LCME.³¹ This collaborative approach may also provide an opportunity to assess outcomes and competency across multiple domains and points of contact along a trainee’s development, which is increasingly important in this milestone- and competency-based educational environment. Peer-reviewed, educational material from sleep experts, designed for institutions that may have limited sleep medicine faculty expertise, is available through the AAN as well as the American Academy of Sleep Medicine (AASM).^{32,33}

Strategy 3: Incorporate recommended educational and online sleep educational resources

The suggested curriculum proposes a sleep educational exposure time of 2–4 hours per year in the form of lectures, flipped-classroom sessions, clinical opportunities, and online educational tools. This would result in a 200%–400% increase in the amount of exposure that US medical schools currently provide, while still only representing a small fraction of the overall educational time. It would also allow integration into existing problem-based, organ system, and topical educational

curricula.³⁴ Technological advances in interactive and mobile educational platforms have opened up opportunities to incorporate targeted sleep medicine education despite the ongoing challenges (e.g., efforts to decrease classroom time and increase independent study, limited resources, and lack of sleep specialists). In a study of internal medicine and emergency medicine trainees, 33% of respondents reported that they already use medical and patient care apps on their smartphones for clinical purposes.³⁵

Students' current rate of engagement with clinical apps provides an avenue to incorporate some of the existing peer-reviewed, sleep-educational mobile and online resources. Some examples of resources from the AAN and AASM have been provided in this article, and the number and diversity of these types of resources are only expected to increase. In addition, self-directed learning as a pedagogical approach has proven effective across various specialties, in which students discover and address their own knowledge gaps through the application of their skills.³⁶ Mobile and online educational resources may also allow for more interactive and personalized engagement with the material. Offering sleep medicine electives, as well as wellness and sleep health opportunities, can also provide further exposure. A conscious effort to house and include exposure to sleep medicine in the neurology clerkship could provide additional experiential learning with neurologic patients. Finally, course directors may consider collaboration with sleep specialists (when accessible) to serve as preceptors for clinical rotations, teaching sessions, or to develop sleep disorder scenarios for standardized patient encounters, clinical writeups, or small group discussions.

Discussion

Despite improved awareness of sleep disorders, a large proportion remain undiagnosed or misdiagnosed.²⁴ The growing need for sleep clinical care within the health care system will increasingly exceed the supply of specialty-trained sleep physicians. Thus, the next generation of physicians needs to be familiar with sleep medicine. Early and ongoing exposure is essential to ensuring competence of future clinicians, who will undoubtedly encounter patients with sleep disorders. Currently, in selected residency programs (neurology, internal medicine, otolaryngology, pediatrics, psychiatry, urology) where trainees are likely to encounter patients with comorbid sleep disorders, the number of educational hours are still inadequate based on a recent National Academy of Medicine report.³⁷ Thus, medical schools will increasingly be expected to graduate competent trainees who have the knowledge, skills, and attitudes necessary to evaluate, triage, and manage common sleep disorders within their patient populations. Understanding the tightly structured curriculum present in most medical schools, we have detailed an approach that emphasizes efficiency and an expected seamless integration into an existing medical school curricular timeline, through the neuroscience and clinical neurology courses.

Presently, medical students learn in academic settings where sleep specialists are more likely to be available and accessible to them and to fellow educators. However, upon entry into practice settings where sleep specialists may not exist or are in limited supply, these medical students quickly realize that they are not armed with the ability to identify, triage, assess, or treat sleep problems sufficiently.³⁸ Thus, guidelines regarding standardized content, recommendations regarding various pathways to deliver that content, and valid resources are paramount to enhancing medical school curricula and providing all US medical school graduates with the opportunity to develop the basic knowledge and skills of sleep medicine. We hope through this guide to demonstrate the importance and feasibility of housing sleep medicine learning objectives within neuroscience and clinical neurology curricula.

Author contributions

Rachel Marie E. Salas: concept and design, interpretation of literature, drafting and revising manuscript. Roy E. Strowd: interpretation of literature, critical revision of manuscript, intellectual content. Imran Ali: interpretation of literature, critical revision of manuscript, intellectual content. Madhu Soni: interpretation of literature, critical revision of manuscript, intellectual content. Logan Schneider: interpretation of literature, critical revision of manuscript, intellectual content. Joseph Safdieh: interpretation of literature, critical revision of manuscript, intellectual content. Bradley V. Vaughn: interpretation of literature, critical revision of manuscript, intellectual content. Alon Y. Avidan: interpretation of literature, critical revision of manuscript, intellectual content. Jane B. Jeffery: review, acquisition of data, drafting and revising of manuscript. Charlene E. Gamaldo: concept and design, interpretation of literature, drafting and revising manuscript.

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