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Editorial

Current status of sleep medicine today and future trends: an editorial

1. State of sleep medicine today

Sleep medicine today is at a critical crossroads for various reasons (political, personal preferences and survival). However, following a period of tremendous growth and excitement over the past 35–40 years the progress in clinical sleep medicine seems to have stalled. For example, the number of applications for Fellowship Training in sleep medicine has been falling in the last three years because of the possibility (correctly or incorrectly) of reduced reimbursement and income potential. Possible reasons include the recent push for Homes Sleep Apnea Testing (HSAT) and denial of in-Lab sleep testing (more about that later) by the third party payors as well as the centers for Medicare and Medicaid Services (CMS) reducing considerably the income potential for sleep medicine practitioners.

We have come a long way in our understanding of sleep since the Assyrian, Babylonian, Egyptian, Indian, and Chinese civilizations (circa 4000-3000 BCE) to Hippocrates, the father of modern allopathic medicine (circa 400-300 BCE). Contemporary sleep medicine has been on a spectacular journey to advancement in basic science, technical aspects and clinical development since the electrifying discovery of rapid eye movement (REM) sleep in 1953 by graduate student Aserinksy and his mentor sleep scientist Kleitman from the University of Chicago [1]. The rest is history.

Before I address the state of sleep medicine today and future trends let me briefly mention to you *why we should care about sleep*. Is it because we spend about one third of our lives sleeping? Because we die a little every night during sleep? It is, of course, important to know this state, for many more reasons than my queries.

I would like to give you some facts about sleep and talk about the magnitude of the problem. What happens if we do not have adequate amount of sleep? Sleep is crucial for our emotional, mental and behavioral development, and for scholastic as well as other career enhancing activities. Sleep is now being recognized as a vital sign for one's general health.

Our society is chronically sleep deprived. Sleep deprivation causes both short-term and long-term consequences. Short-term effects include daytime sleepiness, fatigue, accidents at work, home and on the road; particularly compromising driving safety, inattention, and memory impairment. Long-term consequences consist of obesity, metabolic syndrome (including type 2 diabetes mellitus), heart disease, stroke, impaired memory and predisposition to neurodegenerative diseases (eg, Alzheimer's disease, Parkinson's disease, and others).

The following facts are derived from the National Commission for Sleep Disorder Research (NCSDR, 1993 [2]) and National Sleep Foundation (NSF) [3] Survey Data:

- An estimated 35 million Americans suffer from insomnia;
- An estimated 15–20 million Americans suffer from sleep apnea;
- Hundreds of thousands of Americans experience uncontrollable sleepiness during the day as a result of a sleep disorder called narcolepsy (at least 250,000 suffer from this) or idiopathic hypersomnia;
- An estimated 12 million Americans suffer from restless legs syndrome (RLS);
- More than 15 million Americans are shift workers and of these up to 10% may suffer from shift work disorder (SWD);
- More than 200,000 crashes on the road are related to drowsy driving (data from the National Highway Traffic Safety Administration [NHTSA] [4]); thousands die on US Highways annually because someone fell asleep at the wheel.

Following are some memorable international catastrophes related partly to key personnel's sleep deprivation and resultant fatigue [2]:

- The 1984 Bhopal, (India) Gas Leak (chemical disaster in Union Carbide, India, LTD);
- The 1986 Chernobyl Nuclear power plant disaster in Ukraine (in former USSR);
- The 1986 Challenger Space Shuttle disaster in the USA;
- The 1989 Exxon Valdez oil spill in Alaska, USA.

2. Sleep science and commercilization

I like to say a few words about sleep science vs commercialization of sleep medicine. It is a pity that we are failing to inspire our younger generation to delve into sleep science to understand many unknown facts about sleep (eg, What is sleep? Why do we sleep? We still do not have answers to these age-old questions). We need intensive basic science research to answer these critical questions. Unfortunately, we are seeing the commercialization of sleep medicine and cheap marketing gimmickry.

A balance is needed between sleep science and commercial aspects of sleep medicine. Let me explain. Sleep science and sleep medicine practice are intertwined. The scientific aspect of sleep medicine is directed at advancing sleep sciences whereas the practice of sleep medicine is directed at giving as best patient care as possible as well as generating a decent income within a competing environment to compensate for the ever-increasing office expenses to maintain the standard of practice. A high standard of practice of sleep medicine will generate increasing number of patient referrals to the clinic or office thus indirectly generating more income. But it may not be evident immediately and one must have long-term

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vision to understand this critical point. For practicing high standard of sleep medicine one must have a strong academic background, and therefore, education and research support for the staff must be given a top priority. One could make a case that there are methodological differences in emphasis of scholarship between those who practice in academically oriented universities, medical school affiliated institutions or hospitals versus those who focus on private practice. However, referrals from these physicians in practice are important; therefore, such physicians must have awareness and education about sleep and its disorders. In addition, there are often self-referrals and to encourage such the lay public must be educated so that they are aware about the significance of a good night's sleep (and its dysfunction), and how this impacts their day-to-day activities.

Despite an explosion of knowledge and ready availability of information on the internet and mass media, public and professional awareness as well as education about the importance of sleep are still necessary. Resistance and ignorance continue to pervade society. A case in point: the public and general physicians are still trying to ignore “snoring” perceiving this as a “nuisance” and not harmful in the short or long-term. The facts (eg, scientific epidemiological studies) tell a different story. A popular expression of many patients we see in the clinic is this; “snoring does not bother me and I sleep very well” (meaning fragmented sleep with repeated brief awakenings of which the subject is not aware). Yet, one should ask every such person this question: “How do you feel when you wake up and are out of bed first thing in the morning?” The answer may surprise you. Undoubtedly, some will say “fine”, but a large majority will tell you “well I feel somewhat groggy and tired”. That answer is a red flag and should alert one to think “why?“. Is it due to “fragmented sleep” causing an inadequate amount of sleep resulting in prolonged “sleep inertia” (a tell-tale sign of hypersomnolence) as well as daytime fatigue and excessive sleepiness? There is a need to bridge the current educational gap about sleep disorders (dysfunction) to improve sleep health regionally, nationally and internationally. The key phrase is “sleep health” or the quality of sleep.

3. Social jetlag

Let me now briefly touch on the relatively new concept of “social jetlag”- another curse of modern society causing adverse health outcomes and unhealthy lifestyle choices. The term “social jetlag” was coined in 2006 by Wittmann and colleagues from the division of circadian biology led by Roennenberg in Munich, Germany [5]. Social jetlag is defined as a misalignment between preferred sleep time (biological clock) and sleep times determined by social obligations, such as work or study (ie, “social time”). This is measured as the time difference between midpoints of sleep on weekdays (working during daytime) and weekend days (off work, free time or social time). The critical threshold is > 1–2 h.

As a result of social jetlag there is a pressure to sleep at biologically inappropriate times. This is somewhat similar to shift work in our 24/7 society (approximately 25 million people are shift workers in the USA). This inappropriate sleep time related to either social jetlag or shiftwork started since the discovery of incandescent lightbulbs by Edison in 1879 in Menlo Park, Edison, New Jersey [6]. The situation has recently taken a turn for the worse (see Sleep Time Related Information and Communication Technology [STRICT, [7]). Social jetlag is unlikely to be eliminated (ie, a degree of social jetlag is inescapable) in contrast to the temporary “jetlag” after air travel crossing several time zones. What are the sociodemographic and behavioral correlations of social jetlag? This condition is very common among middle to high school and college students (physiological [8]) and among shift workers (some of these workers develop sleep disorder [pathological] called shift work disorder [SWD, [9]).

Factors predisposing to social jetlag include societal and peer pressure, availability of new technology (eg, smartphones), as well as media use and internet access (STRICT) before bedtime [7,8]. There is a strong association between social jetlag and adverse health outcomes requiring appropriate public health interventions to improve sleep and health in the general population (particular target populations include middle school, high school, and college students [7,8]). Some examples of adverse health outcomes related to social jetlag consist of the following [8,10–18]: reduced cognition; lower academic achievement; aggression in young adults; increased prevalence of metabolic syndrome (including type 2 diabetes mellitus and obesity); depression; absenteeism (absent from or late to work and class); workplace errors; excessive daytime sleepiness (eg, falling asleep at work or in class and other inappropriate times); and impaired driver alertness (compromising driving safety issues). What is the prevalence of social jetlag? This knowledge is somewhat limited. In a Dutch sample of middle-aged adults, the prevalence of more than one hour of social jet lag was 39% [13]. Ronnenberg et al., in 2012 reported a prevalence of about 70% in German participants (14–94 years) [11]. A recent Australian National Sleep Health Survey reported a prevalence of about 30% [14]. All these studies have been cross sectional and hence causality cannot be determined.

I will mention briefly about a new development in sleep medicine:

4. Tele-*sleep medicine*

Tele-*sleep medicine* is defined as online video sleep medicine consultation for diagnosis, designing appropriate tests, disseminating test results and prescribing appropriate treatment [19]. The following factors prompted development and increasing use of telemedicine: i. increasing demand for sleep medicine consultation; ii. convenience (eg, one does not have to travel to the clinic or doctor's office); and iii. possible health care cost containment.

Comprehensive online telemedicine plays an important role in overcoming many of the barriers to sleep medicine practice, addressing the following significant sleep problems: i. inadequate and insufficient sleep (sleep derivation), and chronic insomnia disorder; ii. excessive daytime sleepiness (as in obstructive sleep apnea [OSA], narcolepsy, medication-related and other comorbid medical, neurological and psychiatric conditions) causing adverse health outcomes; iii. sleeping in an inappropriate time (eg, as in circadian rhythm sleep disorders such as shift work disorder, social jetlag, etc.); and iv. sleep accompanied by dream enacting behavior, and other simple and complex movements disturbing sleep causing daytime consequences.

One must remember the pitfalls and dangers of tele-*sleep medicine* practice, which may be summarized as the inherent and sometimes insurmountable problem in online video sleep medicine consultation from a distance [20,21]; ii. both false positive and false negative outcomes causing adverse long-term health-related consequences and increased cost; iii. inadequate attention to potential problems resulting in serious bias in practice; iv. danger of sacrificing quality of care and long-term goals for short-term benefit; and v. (one of the most concerning aspects) it is not currently evidenced based.

In addition, other limitations and barriers to tele-*sleep medicine* practice include [17]:

i. Reimbursement issues: limited and fragmented insurance reimbursement which may create a critical danger of overuse;

ii. Clinical barriers: reduced quality of physical examination and care as well as impaired physician-patient relationship posing potential danger for abuse and fragmented care;
iii. Legal issues: consist of variable state license laws, questions regarding credentialing at multiple sites and liability concerns;
iv. Social barriers: differential and limited access to digital technologies and internet, particularly for the elderly community and underserved populations.

5. My vision on future development of sleep medicine

I envision the following development for sleep medicine in the future:

1. There will be increasing use of Home Sleep Apnea Testing (HSAT) or so-called ambulatory recording because of increasing push from both government and private sectors despite its current inadequacy and pitfalls as a diagnostic procedure. Whether we like it or not, HSAT with rapidly improving technology (eg, incorporation of simultaneous Video-EEG recordings) is going to be an important addition to practice of future sleep medicine. Patient comfort, convenience and cost containment will be the driving forces for its increasing use (but one must beware of the pitfalls and limitations).
2. There will be an increasing application of tele-*sleep medicine* practice (ie, telemetric transmission and monitoring of data, and online video consultation) concomitant with rapidly improving consumer oriented sleep technology (COST). However, a word of caution, one must pay attention to disadvantage and barriers as outlined above.
3. I anticipate greater application of Actigraphy (obtaining data from a watch-like device worn on the non-dominant wrist recording body movements day and night except when taking a shower functioning as a surrogate for sleep-wake states) for its ability to record sleep-wakefulness indirectly for days to weeks in subjects' natural environment. This is an important addition to practice of sleep medicine for diagnosing chronic insomnia and circadian rhythm sleep disorders (eg, shift work and delayed sleep phase disorder, etc.).
4. There will be a push for an increasing study of sleep in conditions of extreme environment (eg, space travel [which is going to happen often], polar regions [eg, Arctic with human inhabitants at present and Antarctic [predominantly occupied by research personnel], high altitude [mountain climbers and those living at altitude of 3000 m or more above sea level], deep sea divers and extremely hot environments [eg, tropical and subtropical regions]) as these situations will be increasingly encountered, demanding such studies.
5. I anticipate improved software for computerized scoring of sleep and other physiological parameters; which will eliminate inconvenience, save time and contain cost.
6. There will be improved smartphones capable of recording sleep wake states and other physiological characteristics throughout the day and night for days to weeks (another word of caution, beware of the danger of false positive and false negative data as are now rampant).
7. I anticipate progress in sophisticated neuroimaging technology including functional magnetic resonance imaging (fMRI) and its application in understanding pathophysiology of sleep and its disorders.
8. I envision a new understanding of insomnia (the most common sleep disorder in the general population) along with the development of new and better sleeping medications for short-term or intermittent use, as well as improved cognitive behavioral therapy for chronic insomnia (CBT-I).
9. I anticipate the approval of emerging therapy for narcolepsy based on new understanding and confirmation of a possible autoimmune mechanism in its causation consisting of immunotherapy, hypocretin agonist treatment, gene therapy and stem cell transplantation.
10. There will be developments in pharmacotherapy, and better non-invasive devices for upper airway pressurization, improved oral appliances as well as better and improved invasive implantable devices for treatment of OSA and central sleep apnea (CSA).
11. Sleep and its dysfunction are going to play a significant role in every aspect of human body and its aliments. We have already seen its importance in the pathogenesis of dementia, particularly Alzheimer's disease (60% of all dementing illnesses in the elderly) and other neurodegenerative diseases such as Parkinson's disease (PD), in which sleep dysfunction is an important non-motor manifestation preceding the onset of classic motor features of this disease by many years.
12. An important area of research in future will be finding a better biomarker(s) based on solid scientific data in REM sleep Behavior Disorder (RBD) which is considered a prodromal manifestation of a neurodegenerative disease with phenoconversion after a variable period to PD, Diffuse Lewy body Disease (DLBD), Multiple System Atrophy. Further, it is hoped that concomitant development of a neuroprotective agent to prevent its conversion to a neurodegenerative disease will be available in the future.
13. I anticipate development of better treatment for circadian rhythm sleep disorders (eg, shift work sleep disorder and others), bright light therapy (already in use), as well as identifying a particular wave length, intensity, color (eg, minimizing blue light exposure) and ideal duration that are optimal for such application. Furthermore, I believe that a better exogenous melatonin, melatonin receptor agonists or other drugs to entrain (ie, to synchronize body and environmental clocks) body's rhythms will be found.
14. Additional services predicted for future sleep medicine practice: sleep medicine department (or division) as well as sleep medicine clinics and labs may benefit by offering additional resources as follows:
    a. Home screening for sleep apnea by finger oximetry (must be cognizant of the problems associated with this device);
    b. Sleep recordings for pediatric patients (currently provided by many but not all labs) because of increasing interest and knowledge of this critical childhood problem (ie, awareness of sleep dysfunction and its devastating effects on children's health);
    c. Incorporation of EEG channels in ambulatory recording including prolonged Video-EEG monitoring (must be aware of pitfalls with ambulatory recording);
    d. Referrals for special EMG studies including incorporation of multiple muscle EMG channels in the existing PSG recording (include cranially and spinally innervated muscles which should include facial [submental, masseter, orbicularis oris, mentalis muscles], trunk, upper and lower limb muscles) to facilitate diagnosis and understanding of NREM and REM parasomnias as well as other abnormal nocturnal movements in sleep.
    e. Mask fitting and monitoring clinics in the sleep department (division) [already provided by many (but not all),

particularly by the academically oriented sleep centers for patient comfort and mask related problem solving];
f. Providing DME services for mask, upper airway pressurization equipment (CPAP) and all supplies.

15. Finally, artificial intelligence (AI) including machine learning (ML), a rapidly growing field in computer technology is going to influence sleep medicine practice. The eventual successful development of this technology may on the surface seem to pose a threat to information technology (IT) workers but it should be viewed as a useful and advanced complimentary aid which will improve human thinking processes, ultimately enhancing diagnostic and therapeutic ability. However, one must remember that AI will always lack human emotion and perception, which are essential elements for human psychological development. Furthermore, ML will never replace human intelligence and subtle touch.

These additional services will no doubt generate new revenues.

6. What would i like to see in sleep medicine's future?

1. To practice sleep medicine according to medical necessity (as determined by sleep clinicians) not dictated by others, particularly third party payors (eg, insurance agents).
2. Continued global promotion of the importance of understanding sleep and its dysfunction, and the promotion of sleep health regionally, nationally, and internationally.
3. Proper use of tele-*sleep medicine* (this is going to increasingly happen in the future but one should be alert to prevent its misuse or overuse).
4. Better understanding of sleep in extreme environment (eg, space travel, polar regions, and high altitude).
5. Better development of sleep equipment for HSAT, which will be utilized more and more in the future.
6. Easy accessibility of and advances in digital media for practicing tele-*sleep medicine* as part of broader tele-health for better patient care in remote and underserved regions. Furthermore, using digital media I would like to advance to sleep health without overusing or improperly using this modern innovative technology (one must, however remember that many individuals, particularly elderly populations have currently no access and are unable to learn this new digital technology).
7. Finally, I would like to see establishment of an Independent Department of Sleep Medicine with its own budget and training program, and its recognition by medical schools and major institutions.

7. Concluding paragraph

We have made valiant efforts in the field and our progress in clinical sleep medicine has come a long way in the last 40 years or so. However, there is still a lot of work to be done. I conclude my editorial by quoting what Robert Frost wrote in 1923 (which remains pertinent today) in the last stanza of his poem “Stopping by the Woods on a Snowy Evening”:

“…*But I have promises to keep*

and miles to go before I sleep

and miles to go before I sleep”.

References

[1] Aserinsky E, Klietman N. Regularly occurring periods of eye motility and concomitant phenomena during sleep. Science 1953;118:273–4.
[2] Wake up America, national commission on sleep disorders. 1993. Washington DC.
[3] Sleep in America 1995 gallup poll: updated CA. 12th ed. 1999. http://www.stanford.edu/~dement/95poll.html.
[4] Stoohs R. Commercial and public transportation impact. In: Kushida CA, editor. Sleep deprivation: clinical issues, pharmacology and sleep loss effects. New York: Marcel Deckker; 2005. p. 273.
[5] Wittmann M, Dinich J, Merrow M, et al. Social jetlag: misalignment of biological and social time. Chronobiol Int 2006;23(1–2):497–509.
[6] Edison discovers lightbulb.
[7] Polos PG, Bhat S, Gupta D, et al. The impact of sleep time-related information and communication technology (STRICT) on sleep patterns and daytime functioning in American adolescents. J Adolesc 2015;44:232–44.
[8] Beauvalet JC, Quiles CL, de Oliveria MAB, et al. Social jet lag in health and behavioral research: a systemic review. Chrono Physiol Ther 2017;7:19–31.
[9] International classification of sleep disorders. 3rd ed. Darien, IL: American Academy of Sleep Medicine; 2014.
[10] Islam Z, Akter S, Kochi T, et al. Association of social jetlag with metabolic syndrome among Japanese working population: the Furukawa nutrition and health study. Sleep Med 2018;51:53–8.
[11] Roennenberg T, Allebrandt KV, Merrow M, et al. Social jetlag and obesity. Curr Biol 2012;22(10):939–43.
[12] Parsons MJ, Moffitt TE, Gregory AM, et al. Social jetlag, obesity and metabolic disorder: investigation in a cohort study. Int J Obes (Lond) 2015;39(5):842–8.
[13] Rutters F, Lemmens SG, Adam TC, et al. Is social jetlag associated with an adverse endocrine, behavioral , and cardiovascular risk profile? J Biol Rhythms 2014;29(5):377–83.
[14] Levandovski R, Dantas G, Fernandes LC, et al. Depression scores associate with chronotype and social jetlag in a rural population. Chronobiol Int 2011;28(9):771–8.
[15] Haraszti RÁ, Ella K, Gyöngyösi N, et al. Social jetlag negatively correlates with academic performance in undergraduates. Chronobiol Int 2014;31(5):603–12.
[16] Randler C, Vollmer C. Aggression in young adults – a matter of short sleep and social jetlag? Psychol Rep 2013;113(3):754–65.
[17] Koopman ADM, Rauh SP, van't Riet E, et al. The association between social jetlag, the metabolic syndrome, and type 2 diabetes mellitus in the general population: the New Hoorn Study. J Biol Rhythm 2017;32(4):359–68.
[18] Wong PM, Hasler BP, Kamarck TW, et al. Social jetlag, chronotype, and cardiometabolic risk. J Clin Endocrinol Metab 2015;100(12):4612–20.
[19] Wechsler LR, Tsao JW, Levine SR, et al. Technology applications: report of the telemedicine work group of the American academy of neurology. Neurology 2013;80:670–6.
[20] Johnston B. Palliative home-based technology from a practitioner's perspective: benefits and disadvantages. Smart Homecare Technol Tele Health 2014;2:121–8.
[21] Muench F. The promises and pitfalls of Digital Technology in its application to alcohol treatment. Alcohol Res 2014;36:131–42.

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