SPECIAL ARTICLE

Treating sleep and circadian problems to promote mental health: perspectives on comorbidity, implementation science and behavior change

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Abstract

Insufficient sleep and mistimed sleep are prominent, yet under-appreciated and understudied, contributors to poor mental health and to mental disorders. The evidence that improving sleep and circadian functioning is an important pathway to mental health continues to mount. The goal of this paper is to highlight three major challenges ahead. Challenge 1 points to the possibility that comorbidity is the norm not the exception for the sleep and circadian disorders that are associated with mental disorders. Hence, the sleep and circadian problems experienced by people diagnosed with a mental disorder may not fit into the neat diagnostic categories of existing nosologies nor be adequately treated with single disorder approaches. The Sleep Health Framework and the Transdiagnostic Intervention for Sleep and Circadian Dysfunction (TranS-C) are discussed as alternative approaches. Challenge 2 points to the large time lag between the development of a treatment and the availability of that treatment in routine clinical practice. This is a key reason for the emergence of implementation science, which is a flourishing, well-developed, and quickly moving field. There is an urgent need for more applications of implementation science within sleep and circadian science. Challenge 3 describes one of the greatest puzzles of our time—the need to unlock the fundamental elements of behavior change. There is potential to harness the science of behavior change to encourage widespread engagement in sleep health behavior and thereby reduce the staggering burden of sleep and circadian problems and the associated mental health problems.

Key words: sleep; circadian; insomnia; sleep health; mental disorder; mental health; behavior change; transdiagnostic; habit formation; memory for treatment; implementation science; comorbidity; subdiagnoses; community mental health

Poor mental health and mental disorders are prevalent [1]. The impact on the individual and society is very substantial [2]. There is evidence that too many treatments delivered for mental disorders do not have an evidence base [3, 4] and it is difficult to access treatment [3, 5], particularly for racial and ethnic minorities [3, 6].

Insufficient sleep and mistimed sleep are prominent, yet underappreciated and understudied, contributors to poor mental health and to mental disorders [7, 8]. Insomnia prospectively predicts mental disorders [9], circadian markers predict symptoms of mental disorders [10], and sleep disturbance is often listed within the diagnostic criteria for mental disorders [11]. Given that one-third of adults living in the United States experience sleep disturbance [12, 13] and many more are not getting enough sleep or the timing of their sleep is not optimal [14, 15], there are a large number of people at risk for adverse mental health outcomes. Of course, this problem extends to children and youth and is not limited to the United States. To the contrary, sleep and circadian problems are global and impact people of all ages, with staggering consequences for the mental health of individuals, families, communities, and nations.

The goal of this paper is to improve knowledge of sleep and circadian functioning as a treatable pathway for improving mental health by articulating three (of the many) major research and clinical challenges ahead. For each challenge, perspectives on possible resolutions are offered. The resolutions draw from a variety of fields and frameworks both within and outside of sleep and circadian science.

While our focus herein is mental health and mental disorders, the issues and approaches may apply equally to physical health and physical illness. While not at all diminishing the importance of a broad range of treatment modalities, evidence-based psychological treatments (EBPTs) for sleep and circadian problems and for mental disorders will be centerstage. EBPTs are interventions that target the psychological processes (e.g., behavior, cognition, emotion) that cause and/or maintain the target problem and that have been developed and evaluated scientifically [16]. EBPTs are clearly effective and are considered to be front-line treatments for many mental disorders [17–19], including insomnia [20, 21]. However, clinicians do not always receive training in or use EBPTs in routine practice [22–24].

Challenge 1. Comorbidity

As we seek to improve knowledge of sleep and circadian functioning as a treatable pathway for improving mental health, a first challenge is to address comorbidity. Strictly speaking, the term "comorbidity" is used to describe a person who meets diagnostic criteria for two or more disorders. The epidemiology that reports the frequency of comorbidity involves large samples and sometimes includes only brief assessments, not the more complex and time-consuming diagnostic interviews that would be ideal. However, it is clear that comorbidity is surprisingly common. In the National Comorbidity Survey replication (*n* = 9,282), comorbidity *within* mental disorders was estimated to be 28% [25]. In a study by the Centers for Disease Control and Prevention (*n* = 10,896), comorbidity *within* sleep-related difficulties was estimated to be 23% [26]. In the Mental Health Epidemiological Catchment Area study (*n* = 7,954) [27] and the National Comorbidity Survey replication (*n* = 9,282) [28], comorbidity *between* sleep and circadian disorder/s *and* mental disorders was estimated to be 40% to 55%. These high rates of comorbidity are important because, relative to people diagnosed with single disorders, people diagnosed with comorbid disorders experience greater severity of symptoms, impairment, and chronicity [25, 29]. Also, a common approach adopted in treatment research has been to focus on a single sleep disorder (e.g., insomnia), in a single mental disorder (e.g., depression), and exclude people who present with other comorbid diagnoses. This approach may result in the exclusion of too many people. As such, furthering knowledge on the patterning and treatment of comorbidity is an critical pursuit for future research. Fortunately, some research groups are already broadening beyond single disorders, broadening the inclusion criteria and minimizing the exclusion criteria for research. For example, Karlin et al.[30] did not exclude people with insomnia who also had mental health and medical comorbidities. Importantly, caution is recommended when interpreting the comorbidity findings as there is a need to address limitations such as sampling bias, inaccuracies due to under-reporting (e.g., embarrassing symptoms) and to address the under-representation of certain groups (e.g., people who are homeless or living in institutions) [25]. Furthermore, there is a need to improve the quality of the measures used, particularly for epidemiological studies of sleep and circadian disorders. Even with these limitations, the importance of grappling with comorbidity is a clear priority.

A related issue is that classification systems specify a clear cut-point, often determined arbitrarily, to define a "disorder". This neglects the group of people who are experiencing significant symptoms but whose symptoms fall just below the cut-point. These people meet criteria for a subdiagnosis, which is defined as the presence of core symptoms of a disorder in the absence of meeting full diagnostic criteria. Although important precedents for examining subdiagnoses of insomnia have been published by Ellis et al.[31] and Morin et al.[32], subdiagnoses are rarely studied.

We have examined full diagnoses and subdiagnoses of sleep and circadian problems in a sample of 121 adults who were receiving treatment in a community mental health center (CMHC) [33]. These people met diagnostic criteria for various mental disorders and reported sleep problems. Interestingly, fewer than 10% met criteria for *only one* full diagnosis sleep or circadian problem. In other words, most people met criteria for comorbid problems. Also, more than 80% of people met criteria for *at least one* subdiagnostic sleep or circadian problem. Replicating prior findings [25, 29], meeting criteria for more full and/or subdiagnostic sleep and circadian comorbidities was associated with overall impairment [33]. There was also significant variation in sleep and circadian problems within the same primary psychiatric diagnosis.[34] This finding adds to the growing recognition of "massive heterogeneity within diagnoses" (p. 181) [35].

While acknowledging that aspects of the diagnostic process was not "gold standard" in the studies just discussed (e.g., dim light melatonin onset is an important assessment tool [15] but was not available), there are two relative certainties. First, there is a high likelihood that full and/or subdiagnostic comorbidity is the norm not the exception for the sleep and circadian disorders that are associated with mental disorders. Second, the sleep and circadian problems experienced by many people do not fit into the existing neat diagnostic categories. This reality begs a question: *Why are most research and treatment development initiatives focused on single disorders?* Consider the example of comorbidity between insomnia *and* hypersomnia which has been observed in major depressive disorder (MDD) [36, 37], bipolar disorder, and schizophrenia [38]. If we focus on just insomnia or just hypersomnia, our research will not generalize to an important subset of people diagnosed with MDD. Similarly, Reeve et al.[39] assessed a sample of young people diagnosed with nonaffective psychosis. Eighty percent were also diagnosed with a sleep disorder and each person was diagnosed with an average of 3.3 sleep disorders. Again, taking a single disorder approach to the research and treatment of nonaffective psychosis will surely miss the mark.

One approach to addressing this problem might be to conduct adaptations to current EBPTs to ensure they fit the clinical realities of each disorder. For example, we initially expected that CBT for insomnia (CBT-I) would be an excellent match for bipolar disorder. To our surprise, as we started to treat people, and examine the literature, it quickly became apparent that in addition to insomnia, hypersomnia [40], delayed sleep phase [41], and irregular sleep-wake schedules [42] were common. Hence,

we decided to adapt the traditional CBT-I protocol to address this broader range of sleep and circadian problems faced by people with bipolar disorder. The effects of the adapted treatment were encouraging for both sleep and mental health outcomes [43] and the adapted treatment was safe for individuals diagnosed with bipolar disorder [44].

However, in hindsight, by creating a single disorder adaptation of CBT-I we inadvertently contributed to an emerging problem, the so-called "too many empirically supported treatments problem" (p. 68) [45]. This is a phrase that has been adopted to refer to the proliferation of EBPTs for mental disorders that are listed by national and international web-based resources, such as the American Psychological Association's Division 12 listing of effective psychological treatments and SAMHSA's National Registry of Evidence-based Programs and Practices. On the one hand, having dozens of EBPTs to select from is wonderful. On the other hand, this situation places an immense burden on clinicians in routine practice who may not know which EBPT to choose and who can't necessarily access training or reach proficiency, in even a small handful of the EBPTs. As such, the proliferation of EBPTs impedes people getting the treatment they need. This problem becomes acute in specific settings, such as the publicly funded network of community mental health centers (CMHC) in the United States that will be discussed later. Alarmingly, with the many complex choices providers need to make, sleep and circadian problems and treatments are often entirely overlooked. Taken together, conducting multiple disorder-focused adaptations—like the adaptation we conducted for bipolar disorder—seems unlikely to address the challenge of comorbidity and may inadvertently add yet another treatment to the long list of EBPTs that clinicians must master. Additionally, the methods used to conduct treatment adaptations is often not optimal. For example, Figure 1 depicts the results of a systematic review of adaptations of EBPTs for mental disorders [46]. As evident, a sizeable number of studies (26%) relied on clinical intuition to complete the adaptation without reference to data, stakeholder interviews, theory, or the existing empirical literature.
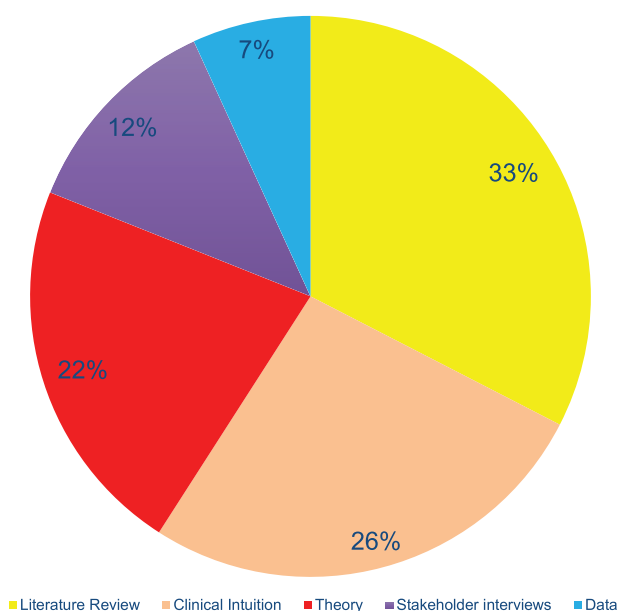
To summarize, as we continue progress toward improving sleep and circadian functioning as a pathway for improving mental health, there is a need to include individuals who are experiencing a range of comorbid full and subdiagnostic diagnoses. Yet, as already mentioned, treatment studies on sleep and circadian disorders and mental disorders tend to be disorder-focused—that is, they treat a specific "single-disorder" sleep or circadian problem (e.g., insomnia) in a specific population (e.g., bipolar disorder). As such, there's a serious mismatch between the complexity of the sleep and circadian problems people are experiencing and the treatments available. The time has come to address sleep and circadian functioning "as the complex, multidimensional phenomenon it really is" (p. ix) [47]. Furthermore, we need to develop treatment approaches that address the complexity of real-life sleep and circadian problems while remaining aware of the "too many empirically supported treatments problem" (p. 68) [45]. This will be a difficult enterprise. It is encouraging to see that multiple scholars [48, 49] and initiatives [35, 50, 51], across various fields, are rising to the challenge of re-organizing research and treatment development efforts to focus on dimensions that cut across disorders rather than on specific single disorders. Two examples, of the many efforts that are underway, will now be described.

The Sleep Health Framework

The Sleep Health Framework [49] is an example of a dimensional approach that has great potential to further the conceptualization and treatment of comorbid sleep and circadian problems. The central premise is that the pathway to improving sleep health involves identifying and treating sleep and circadian disorders while also emphasizing that healthy sleep and circadian functioning is much more than the absence of disorders. Six dimensions that comprise sleep health are articulated in the framework: *regularity* of sleep and waking up; *satisfaction* with sleep or sleep quality; *alertness* during waking hours or daytime sleepiness; appropriate *timing* of sleep within the 24-hour day; *sleep efficiency,* or the ability to sleep for a large percentage of the time in bed, as indicated by ease of falling asleep at the beginning of the night and the ease of returning to sleep after awakenings across the night; and *sleep duration* which is the total amount of sleep obtained across 24 hours. Promoting optimal functioning along all six of these dimensions of sleep health is proposed as the pathway to optimize mental and physical health. The Sleep Health Framework has been the impetus for a range of important advances in the measurement and treatment of sleep and circadian problems [52]. Furthermore, the focus on dimensions (instead of disorders) provides a new way to study, assess and treat people who are experiencing comorbid sleep and circadian problems.

Transdiagnostic Treatments

Within the broader field of clinical psychology, the identification of transdiagnostic processes and the development of transdiagnostic treatments [35, 53] has been proposed to better understand and treat comorbidity across mental disorders [30, 49]. A transdiagnostic process is defined as a process in common across more than one mental disorder [54]. We have been developing a prototype transdiagnostic approach for treating sleep and circadian functioning among those diagnosed with

Figure 1. Sources of treatment adaptation.

mental disorders. This approach is called the Transdiagnostic Sleep and Circadian Intervention or TranS-C [47]. Several forces provided the impetus for developing TranS-C.

First, there is evidence that sleep and circadian problems contribute to the maintenance of mental disorders [7, 8, 55]. Thus, developing a transdiagnostic treatment that efficiently reverses a range of sleep and circadian maintaining processes, across a range of mental disorders, has potential to improve outcome. Furthermore, if this potential was realized, the transdiagnostic solution would be efficient in time and cost as (a) clinicians could be trained in *one* protocol that is helpful across sleep and circadian problems and across mental disorders and (b) patients could receive *one* protocol that would help the comorbid sleep and circadian problems they are experiencing.

Second, there is convergent evidence that CBT-I effectively treats insomnia that is comorbid with a wide range of mental disorders including MDD, posttraumatic stress disorder, substance-related problems [56, 57], schizophrenia [58], and bipolar disorder [40, 44, 55, 59]. Moreover, treating insomnia often improves the symptoms of the comorbid mental disorder [56, 57, 60]. There is no doubt that these are impressive results. However, these studies focus on insomnia whereas people who are diagnosed with a mental disorder experience a broader range of sleep and circadian problems. This observation raises the possibility that a transdiagnostic treatment approach could be developed that includes CBT-I but that addresses the broader range of sleep and circadian dysfunction experienced by people diagnosed with a mental disorder. However, it must be acknowledged that combined approaches, such as TranS-C, are not new. For example, CBT-I has been combined with light therapy [61], medication [62], and continuous positive airway pressure (CPAP) [63].

Third, we are interested in publicly funded clinical settings, such as CMHCs. CMHCs are major providers of treatment for mental disorders in the United States. They provide for the mental health needs of people who are socioeconomically disadvantaged and underserved. CMHCs have been chronically underfunded [64]. The people who receive treatment within CMHCs are typically experiencing high rates of mental health comorbidity and complexity [65], and most are experiencing impairing sleep problems. A fundamental step, before being able to work within any routine practice setting, is to develop a community-research partnership. An essential element of the partnership is that the EBPT to be implemented must be approved by, and generate enthusiasm among, the community partners. In our early rounds of meetings with the leadership of one CMHC—more than a decade ago—there were several concerns raised about the stimulus control and sleep restriction elements of CBT-I. Specifically, given the potential for short-term partial sleep deprivation [66], there were safety concerns given that the people receiving treatment had been diagnosed with a severe mental illness. Furthermore, the CMHC clinicians carry a large and complex caseload and they do not always have time for training and supervision in EBPTs (and often these activities cannot be reimbursed). Hence, there were concerns that the clinicians would not want to deliver the sleep restriction and stimulus control elements of CBT-I. The leadership also felt that the sleep problems experienced by the people who receive treatment within CMHCs often includes insomnia but are more complex. Thus, they concluded that CBT-I would not match the CMHC context. Together, this feedback was a further impetus to developing TranS-C.

Fourth, we were also acutely aware of the large number of people excluded from our treatment research focused on

insomnia disorder. These people were experiencing serious sleep and circadian problems but they didn't meet criteria for insomnia disorder. Thus, the final impetus to developing TranS-C was to meet the needs of this excluded group.

What does TranS-C involve? TranS-C is designed to address and promote improvement along the six dimensions that comprise the Sleep Health Framework. TranS-C is designed to be transdiagnostic in two ways: It includes treatment elements to address a range of sleep and circadian problems across a range of mental disorders. In other words, TranS-C endeavors to provide one treatment to improve a range of sleep and circadian problems (e.g., insomnia, advanced phase, nightmares, adherence to CPAP etc.) for people diagnosed with a range of mental disorders (e.g., bipolar disorder, schizophrenia, depression, anxiety etc.). As such, TranS-C has potential to improve the treatment of comorbidity.

TranS-C takes a modular approach. This decision was based on the evidence that a modular treatment has better uptake by clinicians in routine practice settings, such as CMHCs [67]. Also, within a modular approach, treatment sessions can be "personalized" to the specific sleep and circadian problem(s) experienced by each patient and thus may be more time-efficient. Figure 2 displays the modules that comprise TranS-C. As evident, TranS-C includes four cross-cutting modules featured in every session (case formulation, education, motivational enhancement, and goal-setting), four core modules that constitute the basic building blocks of sleep health and apply to the vast majority of people (establishing regular sleep-wake times including learning a wind-down and wake-up routine, improving daytime functioning, correcting unhelpful sleep-related beliefs, and maintaining behavior change), and seven optional modules used less commonly, depending on the needs of each person (improving sleep efficiency, reducing time in bed, dealing with delayed or advanced phase, reducing sleep-related worry/vigilance, promoting compliance with CPAP/exposure therapy for claustrophobic reactions to CPAP, negotiating sleep in a complicated environment, and treating nightmares). Even though case formulation is a "module" within TranS-C, it is a cross-cutting module. In other words, the initial case formulation is conducted in Session 1 and thereafter becomes a rolling intervention that is woven into all subsequent sessions. This approach incorporates the value Beck [68] places on an "ever-evolving formulation" that unfolds across all sessions. Furthermore, the case formulation approach is well suited to integrating comorbidity into the treatment plan [30]. Several colleagues are in the process of
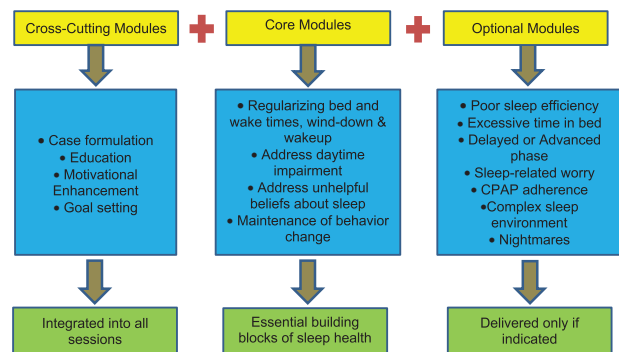

Figure 2. Summary of the Transdiagnostic Sleep and Circadian Treatment (TranS-C).

developing additions, replacements, and improvements on this initial approach.

TranS-C is typically delivered in 8 sessions that are 50 minutes in duration. However, a shorter 4 x 20-minute session version is being tested for CMHC contexts in which there is a need to be working on other issues simultaneously (e.g., threat of homelessness, suicidal thoughts, CBT for anxiety).

How was TranS-C developed? TranS-C is grounded in (a) the basic sleep and circadian science and (b) draws principles from several existing EBPTs. A taster of the way in which the basic science and existing EBPTs will now be provided.

Basic sleep and circadian science

The two-process model [69] is a key part of the foundation for TranS-C. The first process, the *circadian process*, refers to the 24-hour sleep-wake rhythm which is driven by the "master clock" or suprachiasmatic nuclei (SCN) [70]. The process by which the SCN synchronizes to the 24-hour day is called *entrainment*. Entrainment occurs via *zeitgebers* or "time givers", the most powerful of which is the daily light and dark cycle [71]. Interestingly, the SCN can also be entrained by other types of exogenous inputs, such as arousal, activity, social time, meal time, sleep deprivation, and temperature [72]. Hence, TranS-C includes a focus on regularizing the daily rhythm of light and dark and the daily rhythm of nonphotic cues [73]. The second process, the *homeostatic process*, increases our appetite for sleep the longer we are awake. More specifically, the homeostatic pressure to sleep increases during wake and dissipates during sleep [74, 75]. Hence, TranS-C includes interventions for increasing the homeostatic drive to sleep, such as dropping or changing the timing of daytime naps. A third theme that is developed in TranS-C is the need to keep the orchestra of biological clocks within the human body synchronized [76]. Key behaviors that promote a tuneful orchestra of biological clocks include waking up and going to bed around the same time each night. Hence, an important element of TranS-C is to regularize bed and wake times across each week [44].

Evidence-based psychological treatments

In order to intervene on the biology just described, TranS-C draws principles from four existing EBPTs. CBT-I—the front-line treatment for insomnia [20, 21]—is essential to TranS-C. TranS-Cs emphasis on regularizing photic and nonphotic zeitgebers was derived from Interpersonal and Social Rhythm Therapy [73]. The focus on building habits of dim light exposure during the wind-down and across the night and bright light exposure in the morning was derived from Chronotherapy [76, 77] and the emphasis on change talk and on identifying motivational levers was derived from Motivational Interviewing [78].

Preliminary evidence for TranS-C

Two initial tests of TranS-C have yielded promising results. In both studies, we purposefully defined wide open "gates" for the inclusion and exclusion criteria to enhance representativeness and generalizability. The first study was funded by the National Institute of Child Health and Human Development (NICHD) and involved 178 adolescent "night-owls" [79]. The second study was funded by the National Institute of Mental Health (NIMH) and involved 121 adults who met diagnostic criteria for various mental disorders diagnoses [80]. Both studies yielded encouraging findings which varied from small to large effect sizes.

The second study is most relevant to the present discussion [80]. This study was conducted in CMHCs. The demographics of the sample include: annual personal income of $12,500, 70% identified as single, 82% were not employed, 48% lived in supported housing, and 42% identified as African American or Black. The most common mental disorder diagnoses for the sample were: 49% schizophrenia spectrum disorder, 27% anxiety disorder, and 20% substance use disorder. TranS-C was associated with reductions in functional impairment, psychiatric symptoms, sleep disturbance, and sleep-related daytime impairment from pre-treatment to post-treatment. These effects were maintained to 6-month follow-up, except for functional impairment. Also, participants exhibited improvement on a new dimensional measure—the Sleep Health Composite [81]—which is derived from the sum of scores on measures of the six sleep health dimensions from the Sleep Health Framework, as depicted in Table 1. This pattern of results also held for full and subdiagnostic sleep and circadian diagnoses [33].

Future research

On the one hand, there is an immediate pressing need for sleep and circadian interventions to be delivered in routine practice settings, often by clinicians who have minimal or no training in sleep and circadian science nor in EBPTs. Further, there are routine practice settings that do not have the resources to mount trainings and supervision. Multicomponent transdiagnostic treatments, such as TranS-C, may help in that they provide clinicians with one relatively simple approach that is helpful for patients who are experiencing multiple sleep and circadian

Table 1. Sleep Health Framework and Sleep Health Composite Score

Sleep health dimension	Measure
Regularity	Midpoint fluctuation across the daily sleep diary
Satisfaction	Sleep quality question on PROMIS-SD: Item 8 "My sleep quality was: very poor, poor, fair, good, very good"
Alertness	Daytime sleepiness question on PROMIS-SRI: Item 13: "I was sleepy during the daytime: not at all, a little bit, somewhat, quite a bit, very much"
Timing	Mean midpoint across the daily sleep diary
Efficiency	Sleep efficiency based on the daily sleep diary
Duration	Total Sleep Time based on the daily sleep diary

Drawn from Dong et al.[81]

problems (e.g., insomnia, advanced phase, nightmares, CPAP compliance etc). On the other hand, this type of service-oriented research by no means precludes the ongoing desperate need for basic science research into the pathophysiology of the sleep and circadian systems and single modality sleep and circadian treatments (e.g., light therapy, melatonin administration) and for the translation of these into routine practice settings [15]. Both research directions are important.

Finally, it must be recognized that there may be differences between the implementation of protocols in research settings versus routine practice settings. For example, in routine practice settings the implementation of CBT-I—at least by those with specialist training in behavioral sleep medicine—may look like TranS-C. This is an intriguing line of research for the future.

Challenge 2. The Gap Between Science and Practice

Knowledge of the gap between science and practice prompted us to establish a partnership with CMHCs. Although there are several stunning examples of the effective roll-out of EBPTs [82], including CBT-I [30, 83, 84], many innovations related to EBPTs are never rolled out and it has been difficult to scale EBPTs within lower resource or under-funded routine practice settings. Indeed, Balas and Boren [85] have calculated that it takes about 17 years to translate just 14% of original medical research into patient care. This calculation was published more than twenty years ago. Sadly, there is no reason to believe the pattern has changed. The key point is that an alarming amount of innovation will be confined to academic journals for eternity and there is much to be done to ensure that treatments for sleep and circadian functioning are available in all routine practice settings.

Eliminating the time lag between the development of an effective treatment and that treatment becoming available in routine clinical practice is a key reason for the emergence of implementation science. Implementation science is a flourishing, well-developed, and quickly moving field [86]. Implementation science involves: measuring deployment-relevant outcomes (e.g., the acceptability of an intervention to patients, clinicians, and leadership in routine practice settings), studying the process of implementing a new treatment (e.g., documenting the facilitation strategies that are used and how these link to the outcome) and the development of community-academic partnerships [87]. Implementation science is a key priority within the NIMH strategic plan, with the emphasis on supporting research that strengthens the public health impact of the research funded by NIMH. The Sleep Research Society [88] and the European Insomnia Network [89] have both produced ground-breaking white papers listing specific high priority targets for implementation within sleep and circadian science. While the momentum is clearly building, more applications of implementation science within sleep and circadian science are needed [23].

As one example of an implementation science research program, the first step in our CMHC-based research [90] employed the clinicians *within our university setting*. Thus, we could devise their job description to include ample time for training and supervision. While the clinicians were officially employed by the university, their day-to-day activities and their offices were in the CMHCs. This project was funded by NIMH (MH105513). The results were promising and have been discussed earlier in this paper [80]. As a next step, also funded by NIMH (MH120147), we are studying the process and effect of TranS-C when clinicians who are *employed within CMHCs* deliver the treatment. The CMHC clinicians come from a variety of backgrounds and may not have received prior training in EBPTs [91, 92]. CMHCs are under-funded, so the clinicians shoulder a great number of responsibilities, including managing a large caseload of patients who typically have complex needs [64]. Supervision, an important component of most EBPTs in research trials, may or may not be built into routine practice. Moreover, reimbursements for the additional time needed for training and supervision is typically not available. This reality raises a range of implementation science questions that are embedded in the research plan and articulated elsewhere [93] such as: Are the findings replicated when TranS-C is delivered by clinicians in routine practice settings? What dose and type of supervision and training are needed and possible/acceptable to leadership and clinicians within the CMHC setting? Which organizational characteristics best promote the sustainment of implementation efforts, and how can they be cultivated? Which modules within TranS-C are most and least often delivered and why? Does this differ between clinics and why (e.g., organizational culture or leadership characteristics etc.)? Do the clinicians see TranS-C in its current form as a fit for their patients and treatment environment or do adaptations need to be made so that the clinicians are more willing to sustain the practice of delivering TranS-C? Importantly, the gold standard method of observing treatment sessions via audio or video to assess fidelity is typically not realistic in the CMHC setting, so we had to develop a new measure to assess the fidelity of implementing TranS-C that is more feasible for CMHC clinicians [94]. Although these implementation questions/issues are stated in terms of a program of research on TranS-C, they likely apply to the implementation of other sleep and circadian treatments.

Another critical issue is that each routine practice setting varies in domains such as the age, race, ethnicity, and culture of patients, clinicians, and leadership as well as the funding structures and the complexity of problems faced by the patients [95]. As such, EBPTs developed in one setting (e.g., university clinic) may not be a "fit" for all routine practice settings. A lack of fit will hinder implementation as a clinician may decline to deliver the EBPT or may engage in a trial-and-error process of ad hoc modifications, often based on clinical intuition. The latter may reduce fidelity [95, 96]. In our CMHC work, we have conducted informal and formal focus groups and stakeholder meetings to collect qualitative data [97, 98] as a step toward ensuring TranS-C fits the CMHC setting.

In summary, there is an urgent need to draw on implementation science and develop community-academic partnerships to gain much-needed insight into the plethora of questions that remain as we work to ensure that people who are experiencing mental health challenges can access treatment for the sleep and circadian functioning difficulties they experience. This is certainly a complex endeavor given the variety of routine practice settings, the complexity of crossing into a different organizational culture, and the need to provide treatment options that are a fit for high through low resource settings.

Challenge 3. Behavior Change

As we seek to leverage sleep and circadian functioning as a treatable pathway for improving mental health, a third challenge for

future research is: How do we build and adapt interventions to optimize behavior change? Behavior changes are typically fundamental prerequisites for the success of sleep and circadian interventions. People who have been prescribed medications must change their behavior to ensure they take the medication. People who have been prescribed CPAP must use it correctly. People who are receiving CBT-I or TranS-C must try out the behavioral changes that are recommended. Yet research into the science of behavior change in other fields indicates that it is exceptionally difficult for individuals to change these behaviors and there are few behavior change interventions that actually result in lasting change [99]. Indeed, one of the greatest challenges of our time is to unlock the fundamental elements of behavior change. So much so that the NIH common fund, along with 15 NIH Institutes and Centers, have invested in the Science of Behavior Change research network for more than two decades [100].

While the investment in behavior change research is laudable, it is perplexing that sleep health behavior does not typically make it to most behavior change priority lists, which tend to focus on increasing physical activity, enticing people to eat healthier foods, and reducing excessive alcohol intake. Given the clear importance of sleep health behavior for optimal sleep duration and timing, and the importance of sleep and circadian functioning for mental health, applying the science of behavior change to promote engagement in sleep health behaviors is a critical priority too.

At the surface, the sleep health behaviors that need to be adopted to achieve high scores on the six dimensions that comprise the Sleep Health Framework are not difficult to do (e.g., adopting regular bed and wake times). Yet, it is surprisingly difficult for most people to consistently engage in sustained behavior change of any kind, and sleep health behaviors are no exception. Hence, there is a need to uncover the multiple modifiable "steppingstones" to improve sleep health behavior change. Three examples of candidate steppingstones are offered below.

Do People Learn and Remember Treatment Elements?

People accurately recall only about one-third of the recommendations made during a physician visit [101, 102] or a course of CBT-I [103, 104]. Further, the content recalled may be inaccurate [105, 106]. Recall is particularly poor for health behavior change advice [107]. Not surprisingly, poor memory for the content of treatment is associated with poor adherence to medical treatments for chronic conditions [108, 109], which is associated with worse outcome [110].

There are various explanations for these findings [111]. Even when human memory is functioning optimally, fallibility is possible at initial encoding, storage, and retrieval [112]. Also, the odds are stacked *against* people learning, generalizing, and transferring knowledge to new situations; this is known as the transfer of learning problem [113]. Further, memory biases are common [114] and these lead to inaccurate memories.

Our hypothesis is that poor memory for treatment is an important barrier to behavior change because if a person can't recall treatment recommendations, they can't enact them in their everyday life [111]. There is a possible solution. During a treatment session, memory support strategies (see Table 2) can be added to treatment-as-usual to support the encoding

of treatment content [111, 115]. It is important to note that this approach is *not* intended to have a direct effect on improving memory functioning per se. Instead, the focus is on improving the patient's memory *for treatment*.

As an initial step to investigating this novel approach, we conducted a small pilot study comparing cognitive therapy for depression plus memory support to cognitive therapy for depression as usual [138, 139]. The results were encouraging for improving patient memory for treatment and improving some depression outcomes, with small to medium effects. Further, we used the data to derive the optimal dose of memory support for a 50 minute treatment session, which is estimated to be around 12–13 instances of memory support [140].

While awaiting the results of fully powered studies, this line of research is likely to be directly applicable to sleep and circadian interventions given the preliminary data from CBT-I showing that people recall between 20% and 37% of treatment points and poor memory is associated with poorer outcome [103, 104]. More generally, future research to assess the hypothesis that patient memory for sleep and circadian treatment is an important steppingstone on the pathway to sustained engagement in sleep health behavior is needed. A particularly fruitful domain may be to add memory support to digital interventions to determine if memory support provides a further boost to outcome.

Do People Use and Utilize Treatment Elements?

Another key barrier to behavior change is that people may not appraise sleep health behaviors as useful and/or they may not utilize the sleep health behaviors [141]. Inspired by prior research [141], six and twelve months following treatment with TranS-C, we have measured the extent to which adolescents [142] and adults [143] rate various sleep health behaviors as useful and the extent to which they utilize them. Specifically, participants rated the *usefulness* of each sleep health behavior on a 5-point Likert scale (0 = not at all useful; 1 = somewhat useful; 2 = moderately useful; 3 = very useful; 4 = extremely useful). They also rated the *utility* of each sleep health behavior on a 5-point Likert scale (0 = I never use it; 1 = I rarely use it; 2 = I occasionally use it; 3 = I often use it; 4 = I always use it). We were dismayed to learn that, on average, participants appraised the sleep health behaviors as only "moderately useful" and on average they utilized the sleep health behaviors only "occasionally". Furthermore, poorer ratings of the usefulness and utilization of sleep health behaviors were associated with poorer sleep and circadian outcomes.

Taken together, it seems likely that we need to develop innovative strategies to improve patient appraisals of the usefulness of treatment and to increase the utilization of treatment may promote behavior change and thus increase the possibility that sleep and circadian interventions will be associated with sustained change in mental health outcomes. While we await this innovation, clinicians can use existing strategies. For example, given that self-monitoring (e.g., keeping a diary) of behaviors is an effective behavior change strategy [144], clinicians can ask patients to monitor their use and utilization of treatment elements throughout sleep and circadian treatments. If patient use and utilization is low, the clinician should provide a stronger rationale for the recommended sleep health behavior change, explore the patient's beliefs relating to the sleep health behavior, make use of motivational interviewing [78], and work

Table 2. A description of the eight memory support strategies

Memory support	Scientific basis	Example
Attention recruitment	Theories of memory include attention as a core element.[116, 117] Experiments show that engaging attention improves memory.[118–121]	"If there is one thing I hope you to remember in 10-years-time, it is.."
Categorization	Categorizing information improves recall.[122, 123]Given the limited capacity of the human information processing system, binding information into meaningful chunks increases memory capacity.[116, 117]	"Let's create a list of ways to help with waking up at the same time each morning."
Evaluation	Generating and evaluating explanations promotes learning,[124–126], and is more effective than spending twice as much time studying.[127]Evaluation promotes deeper processing[128] as well as conceptual understanding.[129]	"How would this new strategy of waking up at the same time every morning compare to your current habit of waking up any time of the day?"
Application	People fail to apply learned material to a similar situation that only differs in surface features.[46, 130] Practicing the application of new knowledge in a variety of contexts assists transfer of learning.	"Can you think of a way to try one of these relax the mind skills when you can't get back to sleep in the early hours of the morning?"
Repetition	There is robust evidence that repetition automatizes new knowledge.[131, 132]	"In sum, this coming week try spending 6 hours in bed and continue to keep your sleep diary."
Practice remembering	Regenerating, restating and/or rephrasing information improves learning.[133, 134]	"What are some of the main ideas in stimulus control?"
Cue-based reminders	Establishing cues that provide reminders increase the potential for transfer of learning.[57,58]	"Would placing a yellow post-it note on your bathroom mirror help to remind you to use these energy generating skills throughout the day?"
Praising recall	Classic experiments demonstrate that positive consequences for a behavior increases the probability of that behavior.[135–137]	"It's really great that you remembered that point!"

with the patient to identify and remove obstacles to utilizing sleep health behavior.

Do People Form New Habits?

"The more of the details of our daily life we can hand over to the effortless custody of automatism, the more our higher powers of mind will be set free for their own proper work" (p. 38) [145]. Following this observation by William James, as we deliver sleep and circadian treatments, could we explicitly leverage the science of habit formation to ensure that key sleep health behaviors become habits that will last a lifetime [146]?

Figure 3 depicts the habit formation process for one sleep health behavior—waking at about the same time each morning. As evident, habit formation is a learning process whereby a cue (yellow) to the desired behavior (blue), via repetition (red), [147, 148] eventually yields an automatic impulse to engage in the habit (green). Repetition reinforces the behavior-context association (orange). Rewards/reinforcers (purple) promote repetition [149]. The resulting habit is elicited with minimal prior deliberation and persists as long as the cue continues to be encountered [148, 150].

We do not yet know the extent to which treatments for sleep and circadian problems result in the formation of new long-lasting habits. We also don't know if existing sleep and circadian treatments effectively dismantle habits that are antithetical to sleep health (e.g., answering work email during an awakening in the middle of the night). It is probably safe to speculate that the task of infusing our existing sleep and circadian treatments with the science of habit formation will not be straightforward. In particular, from the health psychology literature, we know that the process of habit formation

can take as long as 36 weeks [147–153]. There is variation in the time it takes to develop a habit. This is likely due to individual differences and also the characteristics of the habit itself. Meanwhile, treatments like CBT-I and TranS-C tend to be delivered in 4–8 weekly sessions and thus may not enable the amount of repetition that we know is needed for habit formation. Importantly, the types of habits studied to date tend to be fairly discrete (e.g., increasing physical activity [152]). In contrast, the "bundles" of behavior changes that are needed for CBT-I and TranS-C—including building some habits and disrupting others—are not yet adequately studied. Hence, infusing the science of habit formation and disruption into our existing interventions is proposed as a fruitful domain ahead for promoting sleep health behavior change so as to improve mental health [146].

Closing Remarks

This paper has focused on mental disorders and mental health, although the issues and approaches discussed may apply to physical illness and physical health. EBPTs for sleep and circadian problems and for mental disorders have been emphasized, yet the ideas may apply to other treatment modalities (e.g., memory support could be added to instructions on how to use CPAP). Most of the data presented was collected from adults. There is a great need to examine these topics across the lifespan, including the relevance for children and adolescents. The focus of this paper has been on individuals. It is critical to also understand how individual factors interact with sociodemographic, interpersonal, community, and societal factors, as these constitute important modifiable pathways to address social disadvantage and health inequities [52].
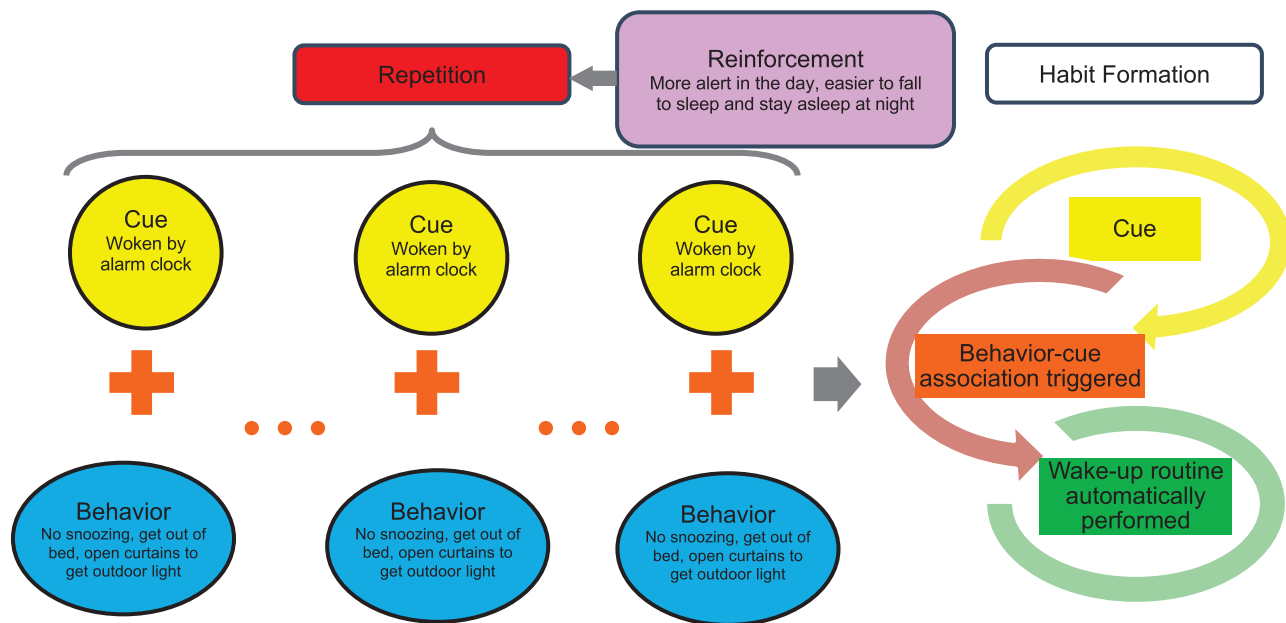
Figure 3. The process of habit formation: forming a wake-up routine.

With the goal of improving knowledge of sleep and circadian functioning as a treatable pathway for improving mental health, three (of the many!) major challenges ahead have been highlighted. For each challenge, perspectives on possible resolutions and future research have been offered. At this point, there are many questions and only preliminary answers. Yet, it seems likely that a new horizon ahead is to move beyond single-disorder focused research to embrace all of the complexity and multi-dimensionality of the sleep and circadian problems experienced by people diagnosed with a mental disorder. Further, implementation science offers a great deal as we work together to ensure that "bench to bedside" translation of breakthroughs occurs more rapidly, particularly in lower resource and under-funded routine practice settings. Relatedly, there is a pressing need to conduct research within different *types* of routine practice settings. This will aid in our understanding of the interplay between the fit of our treatments and specific clinic contexts. Finally, as engagement in sleep health behaviors would go a long way toward improving sleep and circadian functioning for us all, there is an urgent need to incorporate the science of behavior change within our field. Three steppingstones along the path to promoting sleep health behavior change have been proposed, although there are surely others. Overall, the next phase of innovation ahead is a truly exciting time of ongoing growth, retooling in new fields, creating partnerships with community-based services, and breaking down silos between scientific endeavors.

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