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Circadian Rhythm Sleep–Wake Disorders in Older Adults

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Circadian rhythm sleep disorders; advanced sleep phase; delayed sleep phase; melatonin; circadian rhythm disruption; Alzheimer disease; light therapy

Introduction

The timing, duration and consolidation of human sleep result largely from the interaction of two sleep regulatory systems: the sleep-wake homeostat and the circadian timing system. When these two processes are aligned and functioning optimally, they allow adults to achieve a long, consolidated bout of wakefulness throughout the day and a long and consolidated sleep episode at night. Changes to either process, or a change in how the two processes interact, can result in an inability to fall asleep at the desired time, difficulty remaining asleep, or difficulty remaining awake throughout the desired wake episode. This mismatch between the desired timing of sleep (and wakefulness) and the ability to fall asleep and remain asleep is a hallmark of a distinct class of sleep disorders called the circadian rhythm sleep-wake disorders (CRSWDs). This article discusses the circadian timing system, the role played by the circadian system in sleep-wake regulation, typical changes in circadian regulation of sleep with aging, the CRSWDs and how age influences their diagnosis and treatment, and how neurologic diseases in older patients affect circadian rhythms and sleep.

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Circadian Rhythm Sleep-Wake Disorders

Although surveys [1] suggest that less than 3% of the adult population have a CRSWD, the CRSWDs are often confused with insomnia, resulting in underestimates of the true prevalence. Some estimates are that up to 10% of adult patients with sleep disorders may have a CRSWD [2]. Although some CRSWDs (such as jet lag) can be self-limiting, others, when untreated, can lead to adverse medical, psychological, and social consequences for affected patients. The International Classification of Sleep Disorders classifies CRSWDs as disorders related to the timing of sleep and wakefulness, with 6 subtypes [3]: delayed sleep-wake phase disorder, advanced sleep-wake phase disorder, irregular sleep-wake rhythm disorder, non-24-hour sleep-wake rhythm disorder, jet lag disorder, and shift-work disorder (Table 1). The primary clinical characteristic of all CRSWDs is an inability to fall asleep, remain asleep, and/or wake at the desired time. CRSWDs are thought to arise from a problem with the internal biological clock (circadian timing system) and/or misalignment between the circadian timing system and the external 24-hour environment. This misalignment can be the result of biological and/or behavioral factors [4], and the rates of different CRSWDs vary across age groups.

The Circadian Timing System in Humans

The circadian timing system refers to near-24-hour rhythmicity in many aspects of physiology and behavior, including not only sleep and waking, but hormone secretion, body temperature, and urine production [5–7]. These rhythms are features of individual cells [8] and arise through transcription-translation feedback loops [9]. Coordination of the rhythms among cells within an organ, and between the organ systems of the body, is achieved through signals from a central pacemaker in the hypothalamus, the suprachiasmatic nucleus (SCN) [10]. The SCN not only coordinates the rhythmic activity of the cells and organs within the body but also synchronizes the near-24-hour rhythmic activity of the body with the 24-hour cycle of the external environment, a process called entrainment. A functional circadian timing system allows the organism to predict regular changes that occur in the environment (e.g., sunlight, food availability, presence of predators) and to prepare for those changes, thus providing an adaptive advantage [11].

Because the underlying rhythmicity is close to, but not exactly, 24 hours in cycle length, it must be synchronized or *entrained* to the external 24-hour day on a regular basis. Entrainment of the near-24-hour circadian system to the 24-hour day occurs typically through exposure to signals from the environment, and in the case of humans (as in most other mammals) this is largely done via regular exposure to light during the day and darkness at night. Studies in healthy sighted adults have shown that the period (cycle length) of the circadian system averages around 24.2 hours across age groups [12]. This finding implies that the average adult's circadian system needs to be reset about 10 minutes earlier each day in order to remain synchronized to external clock time, and, if it is not, then the circadian system may drift out of synchrony with external clock time. One example of this desynchronization is what happens to many blind individuals. They complain of cyclic sleep-wake problems, alternating periods when they can sleep well at night and are alert during the day with times when their nighttime sleep is very disturbed and they struggle to remain awake throughout the day [13].

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Although on average human circadian period is 24.2 hours, the range between individuals is about an hour, from approximately 23.5 to 24.5 hours [12]. This means that individuals with the shortest and longest periods need to reset by half an hour each day to remain entrained, and, without that regular resetting, they are even more likely than the average person to drift out of synchronization. Individuals with the shortest and longest periods are therefore most susceptible to non-24-hour sleep-wake rhythm disorder. On average, the circadian period in women is shorter than in men, and significantly more women than men have a period that is less than 24 hours [12]. This difference predisposes women to advanced sleep-wake phase disorder.

Circadian Regulation of Sleep and Wakefulness

KEY POINTS

- The circadian timing system co-regulates the timing, structure, and consolidation of sleep
- The circadian timing system interacts with the sleep-wake homeostat to allow consolidated wakefulness during the day and consolidated sleep at night

The circadian system is a major determinant of the timing of sleep and internal sleep structure in humans [14]. Specialized experimental techniques have been used to separate the circadian and sleep-wake homeostatic influences on sleep in order to understand how each independently influences sleep and wakefulness. Those studies have revealed that although most aspects of sleep are influenced by the biological time at which sleep occurs, the circadian system has its strongest impact on rapid eye movement (REM) sleep, sleep latency, and sleep consolidation [15]. The rhythm in circadian sleep-wake propensity is such that the strongest drive for wakefulness occurs in the evening, close to the end of the usual wake episode (creating the wake maintenance zone or forbidden zone for sleep). Similarly, the strongest drive for sleep occurs in the late night/early morning hours, close to the time of the end of the usual sleep episode. When this rhythm in sleep-wake propensity interacts with the sleep-wake homeostatic process, it results in an ability to remain awake across a long episode each day, and to remain asleep for a long and consolidated time each night. Laboratory studies have shown that the ability to have a long consolidated sleep episode is critically dependent on the proper alignment of the timing of sleep with respect to the underlying circadian rhythm of sleep-wake propensity [15, 16]. Misalignment, such as occurs when night-shift workers attempt to sleep during the day, typically produces an inability to sleep for more than a few hours [17], and can result in shift-work disorder.

Age-Related Changes in Circadian Rhythms

KEY POINTS

- There are age-related changes in the phase (timing) of circadian rhythms
- There are age-related changes in the amplitude of circadian rhythms

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- There are age-related changes how the circadian and sleep homeostatic systems interact
- With advancing age, the ability to sleep at adverse circadian phases is compromised, even in healthy individuals

The timing of the circadian rhythms of body temperature, melatonin, and cortisol have been shown to move earlier, or advance, in older adults when compared with young adults [18]. In addition, there are numerous reports that the amplitude of circadian rhythms, including those of body temperature, melatonin, and other hormones, are reduced in older adults [18]. Studies in animals suggest that these age-related changes in rhythms may be caused by changes in the SCN [19]. In addition to changes in the timing of physiologic rhythms controlled by the circadian timing system, there are also reports that the relative timing of rhythms with respect to sleep-wake timing change with age [20]. This latter finding means that older adults are not only sleeping at a different clock time than young adults, they are also sleeping at a different biological time.

Laboratory studies have shown that the sleep of older adults is much more sensitive to the circadian time at which it occurs than is the sleep of young adults [16], thus making older adults more vulnerable to the CRSWDs jet lag disorder and shift work disorder (discussed later). Studies in which the circadian time of sleep is systematically manipulated have revealed that there may be an age-related reduction in the amplitude of the circadian rhythm of sleep-wake propensity that not only makes it more difficult to sleep at an adverse circadian time but makes consolidation of an extended nighttime sleep episode more difficult [16, 21].

Diagnosis of Circadian Rhythm Sleep-Wake Disorders

As described earlier, CRSWDs are assumed to result from a mismatch between the timing of sleep (and wakefulness) and the underlying circadian rhythm of sleep-wake propensity. Despite this, current standards [3, 22] for diagnosis of a CRSWD do not require assessment of circadian rhythmicity but instead focus on the timing of sleep alone. This lack of circadian rhythm assessment may contribute to the poor treatment outcomes of some patients with CRSWDs [4, 23].

Diagnosis of all CRSWDs requires that three main criteria are met:

- The complaint is chronic
- The affected patient has problems with sleep (difficulty falling asleep, difficulty remaining asleep, or waking too early), difficulty remaining awake (excessive daytime sleepiness), or both
- The sleep-wake problem causes clinically significant distress or impairment of one or more areas of functioning

Depending on the CRSWD, there are additional and/or specific criteria used to make a diagnosis. These are outlined in Box 1.

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Prevalence of Circadian Rhythm Sleep-Wake Disorders in Older Adults

KEY POINTS

- Although CRSWD diagnoses are not common, older adults are much more likely than young adults to be diagnosed with advanced sleep-wake phase disorder and irregular sleep-wake rhythm disorder
- Older individuals are more prone to jet lag disorder and shift-work disorder than their younger counterparts (and even more prone than when they were younger) because of a reduced ability to sleep at adverse circadian phases

Early morning awakening (EMA) is common among older adults [24]. Although some surveys of older adults indicate that 20% to 30% of them report EMA, when individuals with co-morbidities such as depression, pain, physical limitations, and respiratory symptoms are excluded, less than 4% of those remaining have EMA [25]. It is impossible to determine from these subjective complaints whether circadian changes underlie the EMA, although in some cases the EMA meets the criteria for advanced sleep-wake phase disorder. Data from the Münich Chronotype Questionnaire [26] show that about 2% of the overall population have a mid-sleep time on free days earlier than 2 am.

Advanced sleep-wake phase disorder is found more frequently in older adults than in young adults [1, 27, 28]. As outlined in Box 1, delayed sleep-wake phase disorder is found rarely in older adults [27, 29]. Non-24-hour sleep-wake rhythm disorder, although rare in sighted older adults, may develop secondary to loss of vision [30]. Irregular sleep-wake rhythm disorder is also rare and is found most frequently in patients with dementias and in institutionalized individuals [31], likely in part because of the lack of strong daily environmental and behavioral influences that typically synchronize circadian rhythms [32]. Jet lag disorder and shift-work disorder may affect individuals to a greater extent as they age [33, 34], because of typical age-related changes in sleep. This is because the sleep of older adults, even those who are in good health and without sleep disorders, is more vulnerable to misalignment with the circadian rhythm of sleep-wake propensity [16, 20, 21]. As a consequence, older shift workers report more sleep problems [35] and have higher rates of hypnotic use than younger shift workers [36]. In addition, irregular sleep-wake patterns are more prevalent in older adults with current or remitted depression [37], and older adults with a lifetime of major depression have been reported to show different timing of melatonin onset than healthy individuals [38].

Neurologic Implications of Circadian Rhythm Changes in Older Adults

KEY POINTS

- Patients with neurodegenerative diseases show changes in rest-activity patterns and sleep disruptions, and these may be caused by circadian disruption
- Changes in sleep may be an early sign of future neurodegenerative changes

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- Changes in sleep often precede cognitive decline, and more severe sleep changes are associated with faster/greater cognitive decline
- Postoperative delirium, with associated sleep pattern changes, may be a warning sign for later cognitive decline.

As described earlier, it is typical for older adults to experience circadian rhythm changes, and most often these changes go unrecognized unless they are accompanied by significant sleep disturbances or daytime dysfunction. However, there is growing evidence from numerous epidemiological studies that sleep problems in older adults, including modest circadian rhythm changes, might represent an early sign of cognitive decline, potential development of a neurodegenerative disease, and might also be associated with increased mortality [39–46]. A bidirectional relationship between sleep and neurodegeneration has been suggested based on evidence from studies in animals [47–49]. These findings may relate to the discovery of the brain glymphatic system, hypothesized to be responsible for eliminating metabolic waste, including amyloid-β and tau proteins, from the brain during sleep [49, 50].

How circadian rhythm changes are associated with the sleep-cognitive decline relationship are not well understood, because few studies have attempted to measure circadian rhythms [40, 42, 43]. Although actigraphy cannot assess the function of the underlying endogenous circadian pacemaker, rest-activity monitoring by actigraphy is the most commonly reported measure used to monitor the sleep-wake rhythm in older adults. There is evidence from the general population that rest-activity patterns show certain systematic changes with aging, including reduced amplitude and advanced acrophase [51]. Many studies have extracted variables from activity that are associated with cognitive changes in older adults, including interdaily stability (IS, a measure of rest-activity rhythm synchronization to 24-hour clock time), intradaily variability (IV, a measure of rhythm fragmentation), amplitude, as well as acrophase or nadir of activity [42, 43, 52–54]. Recently, researchers have attempted to use features of rest-activity patterns measured by actigraphy to predict the development of cognitive decline or dementia in patients with pre-clinical AD or mild cognitive impairment, although those methods remain experimental. One study presented increased rest-activity rhythm fragmentation without phase change or amplitude was associated with the presence of preclinical amyloid plaque pathology proved by positive amyloid PET finding [55, 56]. Whether those rest-activity changes relate to changes in the circadian timing system remains to be determined. However, two studies of patients with probable Alzheimer disease (AD) found that the acrophase (i.e., timing of the rhythm peak) of the core body temperature rhythms of patients with AD was delayed compared with controls [57, 58], suggesting that there may be circadian changes that underlie the sleep-wake changes.

Another hint that changes in sleep-wake behavior are associated with subsequent cognitive decline occurs in patients experiencing delirium during hospitalization or after major surgery. The sleep-wake behavior in patients experiencing delirium shares similar features with sundown syndrome/day night reversal. One study followed the cognitive status in previously high-functioning patients who experienced postoperative delirium during a hospital stay and found they showed an approximately 3-fold greater rate of decline of cognition in the 36 months after surgery [59]. Difficulty falling asleep in community-dwelling

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older adults is also associated with memory problems [25], and thus these 2 lines of evidence hint that a phase delay or circadian disruption, manifested through altered sleep timing, is associated with cognitive decline. Whether the altered sleep timing (and presumed circadian alteration) is a cause or a symptom of the cognitive decline remains to be determined.

In summary, although it is not always clear that a change in rest-activity patterns represents a change in circadian rhythms, a delay of the rest-activity pattern seems to precede later cognitive decline in the older population. For otherwise healthy older patients who present features of a circadian rhythm sleep-wake disorder, especially a phase delay, careful assessment and monitoring of their cognitive status may be warranted, because of the sleep-wake timing change may be an early indicator of neurodegenerative changes. Longitudinal studies with careful clinical observations that include robust sleep and circadian rhythm measures (such as melatonin secretion) will provide greater insights into how circadian and sleep changes may be associated with neurodegeneration.

Circadian Rhythm Disruption in Older Patients with Neurodegenerative Disease

Patients with neurodegenerative disease commonly present with sleep-wake disturbances and/or sleep disorders (including insomnia, excessive daytime sleepiness, sudden sleep attacks, and REM behavior disorder) at an early stage. These disorders may result from structural changes in the SCN and/or in the way SCN cells communicate [19], because the SCN in patients with AD shows more severe changes compared with age-matched adults without AD [60, 61]. Recent studies suggest that changes in the melanopsin-containing retinal ganglion cells may also occur in patients with neurodegenerative diseases [62, 63], thereby contributing to circadian disruption.

As described earlier, studies that have assessed the rhythm of core body temperature have found a significant delay of the rhythm in patients with probable [58] or actual [64] AD. Some studies have reported that disruption of rhythms in AD may be caused by pathological changes to structures in the light input pathway from the eye to the SCN [65–67].

Sleep disturbance is the most common non-motor manifestation of Parkinson’s disease (PD), with an incidence of 60% to 80% [68, 69]. A recent prospective study found that lower overall activity and a reduction in the day-night difference in actigraphy was associated with a significantly increased risk of developing PD [46]. Insomnia, dream-enacting behaviors, excessive daytime sleepiness, snoring/apnea, restless legs syndrome, and sudden sleep attacks are common sleep complaints in PD. REM behavior disorder is now recognized as an important early non-motor phenomenon associated with later development of PD and Parkinson-Plus syndrome. However, few studies have been done to evaluate circadian markers in patients with PD. Changes in phase and amplitude of the melatonin rhythm in patients with PD have been reported [70, 71], suggesting that circadian dysfunction may be a feature of PD, although further studies are needed to understand whether the observed changes are not only prodromal non-motor features of PD but may also be therapeutic targets. There are also reports of circadian alterations in other neurodegenerative disorders such as progressive supranuclear palsy [72] and Huntington disease [73–75].

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In summary, patients with certain neurodegenerative diseases show sleep-wake changes, and there is some evidence that there may also be circadian changes. However, additional studies measuring circadian markers in connection with clinical features are needed to understand what role the circadian system plays in the sleep-wake changes associated with those neurodegenerative diseases.

Treatment of Circadian Sleep-Wake Disorders in Older Adults

KEY POINTS

- Treatments focus on resetting and/or synchronizing circadian rhythms
- Light therapy and/or melatonin are common strategies
- Much more research is needed to develop clinical guidelines and protocols for the use of light therapy and other treatments for CRSWDs in older adults

As outlined in Table 2, the most common treatments used for CRSWDs are designed to reset or synchronize the circadian timing system. A basic strategy used in all CRSWDs is to have the patient select a sleep time and attempt to strictly adhere to it. In addition, therapies that shift rhythm timing are often used, including bright light therapy and melatonin administration. In some cases, hypnotics to promote sleep and/or stimulants to promote wakefulness are also used. However, much more research is needed to identify new ways to diagnose and choose the best treatment for CRSWDs in patients of all ages [4].

Light Therapy

The timing of light exposure is crucial when using light therapy for the treatment of CRSWDs [76–80]. According to the phase response curves to light, evening/early night light delays circadian phase, whereas late night/early morning light advances circadian phase [81]. In young adults, duration-dependent responses to light have been reported [82, 83], with the maximal responses occurring in the initial minutes of light exposure. In fact, Najjar and Zeitzer [84] reported that intermittent flashes of light can produce significant circadian effects. Although additional studies in clinical populations need to be performed, such findings suggest that patients might not need to remain fixed in front of a light box to achieve phase shifts, improving practicality and compliance. In terms of the optimal intensity for light therapy, there are some reports that older adults may be less sensitive to light than young adults [77, 85, 86], although not all studies have identified an age difference [77, 79]. There is evidence that light transmission is affected by typical age-related changes in the lens of the eye, which may contribute to differential impacts of light therapy between young and older adults [87].

Despite findings from laboratory studies, there are few randomized trials in clinical populations that show the benefit of light therapy for older adults with advanced sleep-wake phase disorder [88], and some studies show little to no impact [89, 90]. Clinical treatment guidelines suggest that there is only weak evidence for evening light therapy in advanced sleep-wake phase disorder [91], and there are no detailed guidelines for the intensity, duration or timing for light therapy [4].

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However, rather than use timed light exposures to shift rhythms, one use of light therapy may be to enhance the overall robustness of circadian rhythmicity in older adults, especially those who are institutionalized, as described below.

Treatment of Irregular Sleep-Wake Disorder in Older Adults

Irregular sleep-wake disorder in older adults is most common in patients with neurodegenerative disease, including AD and other dementias, especially as the disease advances. The disruptive impact of the irregular sleep pattern is one of the main reasons for institutionalization [92, 93]. Several studies have been performed to test whether light interventions improve the sleep in such patients, and there is some evidence that bright light exposure can reduce sleep disturbances and improve rest activity patterns [94–97]. Combined light and melatonin interventions have also been tested, with some finding improvements in sleep and/or behavior [98–100]. Related interventions that include limits on daytime time in bed, increased light exposure during the day and decreased disruptions at night (e.g., noise, caregiver interventions) have been reported to improve sleep-wake function [101].

Treatment of Shift Work Sleep Disorder in Older Adults

Older adults are reported to be less tolerant to shift work [34, 102], and this is typically attributed to the decreased ability of older individuals to sleep at an adverse circadian phase [16].

Non-pharmacologic interventions to treat shift work disorder include bright light exposure in the nighttime work environment and avoiding light on the morning commute home, strategic napping, as well as use of caffeine and other stimulants [103–105]. Although few of those studies have focused on older shift workers exclusively, one study found that a combined intervention of enhanced lighting and scheduled afternoon-evening sleep was effective in improving night-shift alertness and performance in older individuals [106]. When they tested the impact of moving sleep to afternoon-evening hours alone, all participants showed longer actigraphically-recorded sleep, with those instructed to remain in bed for 8 hours showing the longest sleep and best night shift performance [107, 108]. Additional studies testing interventions in older shift workers are needed [109].

Summary

The circadian timing system has a strong impact on the timing, structure, and consolidation of sleep, and interacts with a sleep-wake homeostatic process to allow extended sleep and wake episodes. With age, there are changes to both of these sleep regulatory processes, as well as a change in the way they interact. Those age-related changes in sleep make it more likely that older adults will experience certain CRSWDs, particularly advanced sleep-wake phase disorder, jet lag disorder, and shift-work disorder. In addition, other medical changes that occur with aging can contribute to a greater likelihood of the CRSWD irregular sleep wake rhythm disorder. Although sleep hygiene, bright light therapy, melatonin administration, and other therapies are used to treat the CRSWDs, few systematic studies have been performed to determine the optimal strategy for treating CRSWDs, and few studies have specifically tested the therapies in older adults [4]. These deficiencies are compounded by current standards not requiring assessment of circadian rhythmicity in

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diagnosis of CRSWDs, mainly because of the time and expense of doing so [4]. Thus, there remain significant knowledge gaps in the diagnosis and treatment of CRSWDs, especially in older patients [110].

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Box 1.

Diagnostic criteria for Circadian Rhythm Sleep-Wake Disorders most common in older adults.

Note that assessment of endogenous circadian rhythmicity (e.g., timing of evening melatonin secretion onset) is not required for diagnosis [4].

Main criteria for all CRSWDs: **• The sleep-wake complaint is chronic** **• The patient has a problem with sleep (difficulty falling asleep, remaining asleep, or waking too early), difficulty remaining awake (excessive daytime sleepiness), or both** **• The sleep-wake problem causes clinically significant distress or impairment of one or more areas of daytime functioning**
Advanced sleep-wake phase disorder, additional criteria: ○ An advance in the timing of sleep relative to the desired or required timing, both by history and as evidenced using actigraphy and/or a daily sleep log for at least one week ○ Symptoms/complaint present for at least three months ○ When allowed to sleep without timing constraints, the patient is able to achieve a sleep episode of good quality and sufficient duration, although the timing is advanced ○ The sleep problem is not explained by any other sleep, medical, neurological, or psychological disorder, by medication, or by substance use/abuse
Irregular sleep-wake rhythm disorder, additional criteria: ○ Irregular sleep and wake episodes throughout the 24-hour day, both by history and as evidenced using actigraphy and/or a daily sleep log for at least one week; three or more sleep episodes per 24 hours, difficulty sleeping/remaining asleep at night, difficulty remaining awake during the day ○ Symptoms/complaint present for at least three months ○ The sleep problem is not explained by any other sleep, medical, neurological, or psychological disorder, by medication, or by substance use/abuse
Shift-work disorder, additional criteria: ○ When working a particular shift (night shift or day shift with early morning start time), difficulty sleeping and/or excessive sleepiness, with overall reduced sleep duration by history and as evidenced using actigraphy and/or a daily sleep log for at least one week ○ Symptoms/complaint present for at least three months when on the work schedule ○ The sleep problem is not explained by any other sleep, medical, neurological, or psychological disorder, by medication, by substance use/abuse, or by the patient forgoing daytime sleep to work a second job or perform childcare or other activities
Jet lag disorder, additional criteria: ○ Difficulty sleeping and/or excessive sleepiness, with overall reduced sleep duration following rapid travel across two or more time zones ○ Impairment of function that appears within a few days of the travel ○ The sleep problem is not explained by any other sleep, medical, neurological, or psychological disorder, by medication, or by substance use/abuse

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KEY POINTS

- The circadian timing system regulates the timing, structure, and consolidation of sleep, in conjunction with a sleep-wake homeostatic process
- There are age-related changes in the circadian regulation of sleep, in sleep homeostatic regulation of sleep, and in the interaction between these two processes
- Circadian rhythm sleep wake disorders result from a mismatch between the desired timing of sleep and the ability to fall asleep or remain asleep
- Advanced sleep-wake phase disorder and irregular sleep-wake rhythm disorder are more common in older adults than in young adults
- Jet lag disorder and shift-work disorder are more commonly experienced by travelers and workers as they age

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SYNOPSIS

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

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Table 1.

Characteristics of Circadian Rhythm Sleep-Wake Disorders with special considerations for older patients.

All circadian rhythm sleep-wake disorders are characterized by an inability to fall asleep, remain asleep, and/or awaken at the desired or required time.

Circadian Rhythm Sleep-wake Disorder	Basic Characteristics	Age-related Considerations
Delayed sleep-wake phase disorder	Sleep timing occurs later than desired or required	Less common in older adults
Advanced sleep-wake phase disorder	Sleep timing occurs earlier than desired or required	More common in older adults
Irregular sleep-wake rhythm disorder	Irregularity in sleep-wake timing, often including multiple irregular short sleep bouts within a day	More common in older adults, particularly in the context of dementia and institutionalization
Non-24-hour sleep-wake rhythm disorder	Sleep timing moves progressively later each night (or rarely, moves earlier each night)	More common in older adults, particularly in the context of vision loss
Jet lag disorder	Inability to sleep at night and/or remain awake throughout the day after traveling across several time zones. This condition is caused by the abrupt mismatch between internal biological time and external time resulting from rapid travel across time zones, and is typically self-limiting.	Older adults more affected due to decreased ability to sleep at adverse circadian time
Shift-work disorder	Inability to obtain sufficient sleep during the day and difficulty remaining awake at night to perform night work. Shift work disorder can also impact day workers whose early morning shifts require very early rise times	Older adults may be more susceptible due to decreased ability to sleep during the day

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Table 2.

Common treatments for Circadian Rhythm Sleep-Wake Disorders

CRSWD	Common recommendations and treatments
Advanced sleep-wake phase disorder	• Adhere to a fixed sleep schedule • Evening bright light
Irregular sleep-wake rhythm disorder	• Adhere to a fixed sleep schedule • Daytime bright light • Evening melatonin
Non-24-hour sleep-wake rhythm disorder	• Adhere to a fixed sleep schedule • Chronotherapy • Evening melatonin • Morning bright light exposure
Jet lag disorder	•Adhere to a fixed sleep schedule •Appropriately timed melatonin • Hypnotics • Timed light exposure (including minimizing exposure to bright light at certain times) • Caffeine and other stimulants
Shift-work disorder	•Timed light exposure (including minimizing exposure to bright light on the commute home in the morning) • Appropriately timed melatonin • Modafinil • Strategic napping • Caffeine