# Light Treatment for Sleep Disorders: Consensus Report.

## V. Age-Related Disturbances

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*Abstract* Sleep maintenance insomnia is a major complaint among the elderly. As a result, an inordinate proportion of sleeping pill prescriptions go to individuals over 65 y of age. Because of the substantial problems associated with use of hypnotics in older populations, efforts have been made to develop nondrug treatments for age-related sleep disturbance, including timed exposure to bright light. Such bright light treatments are based on the assumption that age-related sleep disturbance is the consequence of alterations in the usual temporal relationship between body temperature and sleep. Although studies are limited, results strongly suggest that evening bright light exposure is beneficial in alleviating sleep maintenance insomnia in healthy elderly subjects. Less consistent, but generally positive, findings have been reported with regard to bright light treatment of sleep and behavioral disturbance in demented patients. For both groups, it is likely that homeostatic factors also contribute to sleep disturbance, and these may be less influenced by bright light interventions.

*Key words* sleep, circadian rhythms, light, aging, dementia, phototherapy, advance sleep phase syndrome, irregular sleep-wake pattern, body temperature, insomnia

### INTRODUCTION

As of 1990, there were approximately 27 million Americans over the age of 65. A substantial proportion of these individuals, perhaps as much as half, suffer from chronic sleep disturbance. As a consequence, up to 40% of all hypnotic medications are prescribed to the elderly, despite growing evidence that such drugs may not only be ineffective for age-related sleep disturbance, but actually deleterious to the health of older

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individuals. The American Psychiatric Association Task Force on Benzodiazepine Dependency included high dose and advanced age among the conditions most likely to lead to greater risks of chronic toxicity, especially cognitive impairment, and true physiological dependency (American Psychiatric Association, 1990).

The potential difficulties with pharmacological interventions have led to the development of a number of nondrug strategies to alleviate age-related sleep disturbance. The present report examines results of one such strategy—timed exposure to bright light. In the first section, results of studies using sleep-disturbed, but otherwise healthy, older subjects are examined. This is followed by an examination of studies of demented, and other, elderly subjects confined to nursing homes. The final section briefly summarizes the findings and provides recommendations regarding the use of bright light in the treatment of age-related sleep disturbance.

## HEALTHY ELDERLY

The underlying rationale for the use of light therapy to treat sleep disturbance in the elderly is based on characteristic changes in circadian rhythms that accompany aging. With aging, circadian rhythms (e.g., body core temperature) are phase-advance, leading to an altered phase-relationship between the timing of nocturnal sleep and these rhythms. It is this altered phase-relationship that is hypothesized to cause, at least in part, the characteristic sleep disturbance associated with aging. Timed exposure to bright light, then, is used to delay the circadian clock and thereby reinstitute the appropriate phase relationship between the circadian timing system and habitual sleep times. Although several laboratories have documented the nature of both circadian changes and sleep-wake disturbance in aging (Weitzman et al., 1982; Czeisler et al., 1992; Zepelin and McDonald, 1987; Campbell et al., 1989; Moe et al., 1991), few investigators have used light therapy in an effort to manage the problem.

In one study, Campbell and coworkers (Campbell and Dawson, 1991; Campbell et al., 1993) compared the effects of evening bright light exposure (approx. 4000 lux for 2 h) with a dim red light control condition (< 50 lux for 2 h) in older subjects (mean age, 70.4 y) who had experienced sleep maintenance insomnia for at least 1 year prior to enrollment in the study. Following 12 consecutive days of treatment, subjects in the bright light condition exhibited a significant increase in sleep efficiency (baseline, 77.5%; posttreatment, 90.1%), the result of an average 1-h decline in wakefulness within the night. This reduction in waking time (Stage 0) was accompanied by a significant reduction in Stage 1 and by a significant increase in the proportion Stage 2 sleep. Nonsignificant, but perhaps clinically relevant, increases in slow wave sleep (Stages 3 and 4) and REM sleep were also observed in the bright light group. In contrast, those receiving dim light exposure showed no significant change in sleep efficiency, wakefulness within sleep, or any other sleep parameter measured.

Similar findings were reported by Lack and Schumacher (1993) using exposure to evening bright light in a group of early morning awakening insomniacs. Although the study sample had a mean age of only 48 y, the nature of their sleep disturbance was equivalent to that seen in older subjects. In that study, subjects were exposed to either 4 h of evening bright light (2500 lux) or dim red light (200 lux) for two consecutive days (2000 h to 2400 h on the first night, 2100 h to 0100 h on the second). Bright light produced improvements in sleep, as measured by wrist actigraphy and subjective assessment: Self-reported sleep duration increased significantly, whereas actigraph movement time in the first 6 h of sleep declined significantly following treatment. The dim light group showed no such changes in sleep measures. The same results were obtained in a subsequent study of nine subjects (mean age, 53.4 y) with early morning awakening insomnia (Lack and Wright, 1993). Following two consecutive days of bright light exposure (2500 lux from 2000 h to 2400 h), actigraphically measured total sleep time increased by an average of 1.2 h.

In all three studies described above, improvement in sleep was accompanied by significant delays in the circadian course of body core temperature. Campbell and coworkers reported an average phase delay of 3.1 h following treatment. Lack and Schumacher observed phase delays in the temperature minimum of 3 to 4 h, and Lack and Wright reported an average delay of 1.85 h.

## DEMENTED AND OTHER NURSING HOME ELDERLY

In addition to treatment of sleep disturbance per se, light therapy has been used in nursing home populations (primarily demented patients) in an effort to manage behavioral disorders such as night wandering

and "sundowning" (a syndrome of recurring confusion and agitation in the late afternoon or early evening). Because of the methodological and logistic difficulties inherent in obtaining polysomnographic data in demented and other nursing home patients, no encephalogram (EEG) studies of light therapy in this population have been reported. Instead, behavioral observations and objective rest/activity measures have been used to assess efficacy of bright light treatment in demented subjects.

Okawa and coworkers (Okawa et al., 1991) examined the efficacy of morning bright light exposure (3000 lux; 0900 to 1100 h), administered daily for 1 to 2 months, in a group of 24 patients (mean age, 76.6 y) with moderate or severe dementia. The patients were selected specifically because they exhibited irregularity of sleep-wake patterns and behavioral disorders. Using hourly nurses' observations to assess sleep-wake state and other behaviors, the investigators reported improvement in 12 of the 24 patients studied. Subsequently, these patients were assigned to a placebo condition (patients sat in front of lights that were not turned on), and their sleep-wake and behavioral disorders reappeared, suggesting that light exposure, rather than the behavioral structuring that accompanied such a protocol, was the important factor in treatment.

In a subsequent study (Mishima et al., 1994), again using observational data, this group reported significant improvements in nighttime sleep, and a marked reduction in behavioral disorders and daytime sleep, in a group of demented patients (mean age, 75 y) following 4 weeks of morning (0900 to 1100 h) bright light exposure (3000-5000 lux). The effects on nighttime sleep and behavioral disturbance were present 2 weeks following the end of light treatment.

In a preliminary study of 25 nursing home residents (mean age, 87.1 y), Ancoli-Israel et al. (1991) compared effects on sleep of evening bright light (1700 h to 1900 h), morning bright light (0930 h to 1130 h), dim light (1700 h to 1900 h), and increased daytime activity (no time specified). A nonsignificant trend toward improved sleep (inferred from actigraphic data) was found in the evening bright light group, but not in the other conditions.

Satlin and coworkers (1992) used both observational and rest/activity data to assess the effects of evening bright light (approx. 2000 lux; 1900 h to 2100 h) administered daily for 1 week in a group of 10 Alzheimer's inpatients (mean age, 70.1 y). As in the Okawa study, patients who exhibited sundowning behavior and sleep pattern disturbance were specifically selected for participation in the study. Based on nurses' observations, 8 of the 10 patients exhibited improvements in sleep-wakefulness ratings during the week of treatment and during the subsequent week. This result was supported by data obtained from activity monitors worn by each patient. Percentage of nighttime activity declined significantly from the baseline week to the light treatment week in 9 of the 10 patients. As a result, the amplitude of the cosine-fitted activity data showed a significant increase during the treatment week in 7 of the 10 patients. Interestingly, there was a significant positive correlation ($r = 0.65$) between the severity of sundowning symptoms at baseline and the degree of improvement with light treatment.

## CONCLUSION

The application of light therapy to age-related sleep disturbance is quite recent, with no reports appearing in the literature prior to 1991. Thus results are sparse, and those reports that do exist must be viewed as preliminary. Nevertheless, the available evidence indicates that timed exposure to bright light may be an effective means of alleviating sleep maintenance insomnia in healthy elderly and that it may also be beneficial in treating sleep-wake and other behavioral disturbances in demented elderly, at least in the short term. No study has assessed the long-term efficacy of light therapy in either healthy, or pathological, aging. This issue is of critical importance if light therapy is to be useful as a strategy to manage what is typically a chronic problem.

Several methodological issues should be mentioned that are likely to have an impact on the efficacy of light therapy in age-related sleep disturbance. There is good reason to believe that improvement in sleep is associated with a phase delay of the circadian timing system. As such, adequate phase assessment should be made to insure proper timing of light administration. In addition, compliance with the treatment protocol needs to be guaranteed, particularly in terms of direction of gaze, since previous work has shown that only slight deviations from the light source may dramatically reduce illuminance received (Dawson and Campbell, 1990).

Finally, it should be noted that age-related sleep disturbance is almost certainly not caused solely by changes in the circadian timing system. Ample evidence indicates that there are age-related changes in homeo-

static properties of the sleep-wake system (Feinberg and Carlson, 1968; Ingram et al., 1980; Reynolds et al., 1985; Dijk et al., 1989; Ehlers and Kupfer, 1989), which undoubtedly contribute to fragmented sleep and early morning awakenings as well. Therefore, it is probably unrealistic to expect light therapy to be completely effective in alleviating age-related sleep maintenance insomnia.

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## REFERENCES

American Psychiatric Association (1990) Task Force Report, Benzodiazepine Dependence, Toxicity and Abuse. Washington, DC, American Psychiatric Association.

Ancoli-Israel S, Kripke D, Jones D, Parker L, and Hanger M (1991) Light exposure and sleep in nursing home patients. Soc Light Treatment Biol Rhythms Abst 3:18.

Campbell SS and Dawson D (1991) Bright light treatment of sleep disturbance in older subjects. Sleep Res *20*:448.

Campbell SS, Dawson D, and Anderson M (1993) Alleviation of sleep maintenance insomnia with timed exposure to bright light. J Am Geriatr Soc *41*:829-836.

Campbell SS, Gillin JC, Kripke DF, Erikson P, and Clopton P (1989) Gender differences in the circadian temperature rhythms of healthy elderly subjects: Relationships to sleep quality. Sleep *12*:529-536.

Czeisler CA, Dumont M, Duffy JF, Steinberg JD, Richardson GS, Brown EN, Sanchez R, Rios CD, and Ronda JM (1992) Association of sleep-wake habits in older people with changes in output of circadian pacemaker. Lancet *340*:933-936.

Dawson D and Campbell SS (1990) Bright light treatment: Are we keeping our subjects in the dark? Sleep *13*:267-271.

Dijk D-J, Beersma DG, and van der Hoofdakker HR (1989) All night spectral analysis of EEG sleep in young adult and middle-aged male subjects. Neurobiol Aging *10*:677-682.

Ehlers CL and Kupfer DJ (1989) Effects of age on delta and REM sleep parameters. Electroencephalogr Clin Neurophysiol *72*:118-125.

Feinberg I and Carlson V (1968) Sleep patterns as a function of normal and pathological aging in man. Arch Gen Psychiatry *18*:239-250.

Ingram DK, London ED, and Reynolds MA (1980) Sleep and daytime sleepiness in the elderly. J Geriatr Psychiatry *13*:135-151.

Lack L and Schumacher K (1993) Evening light treatment of early morning insomnia. Sleep Res *22*:225.

Lack L and Wright H (1993) The effect of evening bright light in delaying the circadian rhythms and lengthening the sleep of early morning awakening insomniacs. Sleep *16*:436-443.

Mishima K, Okawa M, Hishikawa Y, Hozumi S, Hori H, and Takahashi K (1994) Morning bright light therapy for sleep and behavior disorders in elderly patients with dementia. Acta Psychiatr Scand *89*:1-7.

Moe KE, Prinz PN, Vitiello MV, Marks AL, and Larsen LH (1991) Healthy elderly women and men have different entrained circadian temperature rhythms. J Am Geriatr Soc *39*:383-387.

Okawa M, Hishikawa Y, Hozumi S, and Hori H (1991) Sleep-wake rhythm disorder and phototherapy in elderly patients with dementia. In *Biological Psychiatry*, G Racagri and T Fukuda, eds, pp 837-840, New York, Elsevier Science Publishers.

Reynolds CF, Kupfer DJ, Taska LS, Hoch CH, Sewitch DE, and Grochocinski VJ (1985) Slow wave sleep in elderly depressed, demented and healthy subjects. Sleep *8*:155-159.

Satlin A, Volicer L, Ross V, Herz L, and Campbell S (1992) Bright light treatment of behavioral and sleep disturbances in patients with Alzheimer's disease. Am J Psychiatry *149*:1028-1032.

Weitzman ED, Moline ML, Czeisler CA, and Zimmerman JC (1982) Chronobiology of aging: Temperature, sleep-wake rhythms and entrainment. Neurobiol Aging *3*:299-309.

Zepelin H and McDonald C (1987) Age differences in autonomic variables during sleep. J Gerontol *42*:142-146.