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The Efficacy of Bright Light Therapy in Older Adults with Dementia - A Narrative Review

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Abstract

Background: Dementia is a chronic condition that can have a significant burden on individuals and their caregivers. It poses a global challenge as 55 million people in the world live with this condition. Adults with dementia develop sleep problems and significant behavioral and psychological problems. Although medication is used to treat these symptoms, its use is associated with high-risk side effects like daytime somnolence and increased risk of falls. The administration of bright light therapy (BLT), which is a non-pharmacological therapy, can treat sleep disorders and can be an effective adjunct therapy. However, despite established proof regarding the potential use of light to treat sleep and behavioral disturbances of dementia, we do not have definitive protocols for administration of BLT.

Method: This study is a narrative review identifying and summarizing various studies done to study the efficacy of bright light therapy on patients with dementia. This was done so we could compare the different protocols, the type of light used, the duration of therapy and the positive and negative outcomes of each of these studies.

Results: We compared 14 studies conducted on older adults with dementia, most of them residing in facilities (some residing at home) exposing them to bright light of varying intensities (2500 lux- 10,000 lux) for a duration between 2 weeks to 24 weeks using light boxes, dynamic light therapy or simply by increasing indoor daylight exposure. We noticed that BLT was as-

sociated with an improvement in sleep efficiency along with reduced behavioral and psychological symptoms in almost all the studies.

Conclusion: BLT could be an effective strategy to treat dementia when properly designed and implemented.

Introduction to dementia

Dementia is a condition that causes a decline in cognitive abilities, which affects a person's daily functioning (1). In the United States alone, 7 million people suffer from dementia and the number is expected to be doubled by 2050(2). Five out of every six patients with dementia, including those living at home, develop behavioral and psychological symptoms (3-5). These symptoms include signs and symptoms of disturbed behavior, mood, thought or perception causing agitation, depression, elation, delusions, and hallucinations (6).

Understanding bright light therapy

While pharmacotherapy is widely used to manage symptoms of dementia, its efficacy is mixed, and it carries an increased risk of side effects, including mortality (7-9). However, bright light treatment (BLT) is a feasible non-pharmacological intervention for people with dementia. Studies have reported improvements in agitation, depression, and sleep after BLT (10-12). BLT has no adverse side effects and is a safe, non-pharmacological treatment for dementia patients (13). It involves the controlled application of certain levels of light, which can be administered in various ways, such as through direct sunlight, light boxes, ceiling lights, or dawn-dusk simulation (14).

Neurobiological basis of bright light therapy

Light influences the suprachiasmatic nucleus (SCN) that controls circadian rhythm (15). A circadian rhythm is a series of all the physiological events occurring in 24 hrs in humans and animals. This cycle involves the supra chiasmatic nucleus as well as the anterior hypothalamus which is the master pacemaker. Though circadian oscillations are endogenously generated by the SCN, it also needs external cues. Light exposure is the most important synchronizing agent of endogenous circadian rhythms. Second, light suppresses melatonin secretion, which is important in treating sleep disorders (15). Morning bright light exposure advances the circadian rhythms in patients with insomnia (16) and delays sleep phase syndrome (17).

Melatonin: During the day the suprachiasmatic nucleus decreases the amount of melatonin and during the night this inhibition is stopped promoting wakefulness (18). Through this pathway, MT converts the neural information initiated after the perception of light into biochemical information through the SCN's action on the pineal gland, ultimately affecting the human body's rhythm (19). In Neurodegenerative Diseases, changes in the secretion of MT can cause disorders in the circadian rhythm of the human body.

Retina and Hypothalamus connection: there are specific visual circuits in the brain which are influenced by the bright light therapy (20). The circuits work by converting light information to electrochemical signals transmitted throughout the brain (20-22). In the mammalian retina, there are three types of light-sensitive cells: rods, cones, and intrinsic photosensitive retinal ganglion cells (ipRGCs). IpRGCs not only receive light signals transmitted from rods and cones but also respond directly to external light stimuli and transmit light information to multiple brain regions to regulate the circadian rhythm (23-30). In summary, the neurobiological basis of bright light therapy involves its impact on the circadian rhythm, melatonin production, serotonin and dopamine levels, and the connection between the retina and hypothalamus.

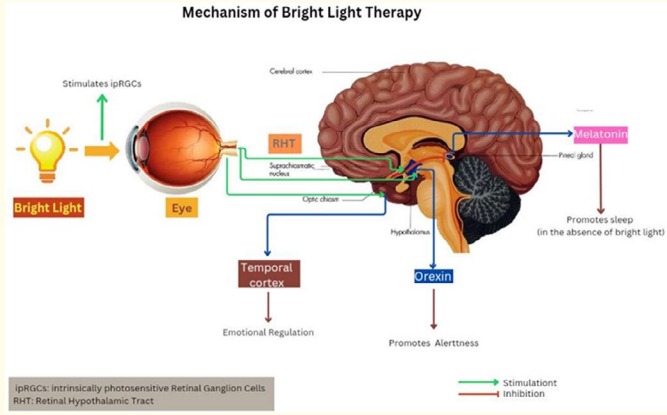

Figure 1: Mechanism of bright light therapy (63).

Efficacy of bright light therapy

Bright light therapy is effective in treating subthreshold depression in college students (31). Fregna et al (2023) noticed that bright light therapy had a significant effect in reducing irritability on patients of bipolar depression (32). Adjuvant light therapy was effective in treating non seasonal depression in drug-resistant patients (33). In the last two decades, the use of bright light therapy has revolutionized, and it has been used to treat chronic depression, antepartum depression and premenstrual depression (34). Ambient bright light treatment can improve sleep in young (35) and older adults (36) and individuals with dementia (37). Studies show that 16 weeks of bright light therapy has improved scores in both neuro psychiatric inventory - nursing homes and Cornell scale for depression in dementia, showing its strong importance in the management of mood related symptoms in people with dementia (38). A study by Figueiro et al revealed that tailored light therapy stimulating the circadian rhythm can improve the duration of sleep and sleep efficiency and can be used in Alzheimer's disease related patients (ADRD) with sleep issues (39). Bright light therapy is also shown to improve the cognitive functions in mild type of dementia (40). In older patients, dawn-dusk stimulation of the circadian rest-activity cycles resulted in greater alertness, better mood, better cheerfulness and better wellbeing (41). Blue light therapy has also shown to improve sleep pattern, duration and quality of sleep among both patients of dementia and care-givers (42). A pilot study revealed that indoor light therapy in people with dementia living in long care facilities resulted in improvement in depression symptoms. This finding is potentially significant because it encourages people to utilize existing daylit spaces to treat dementia and depression in dementia care centers (43).

Keeping in view all the above benefits and implications of light therapy, with minimum adverse effects, light therapy could definitely play an important role in treatment of dementia in the future. In our Study, we will further discuss the current role of bright light therapy on patients with dementia and compare various studies that have researched the effects of bright light therapy on dementia. F.2, 3

Protocol of Bright Light Therapy in Dementia

Light therapy's quicker therapeutic impact often within days of starting treatment, distinguishes it from standard antidepressants. Therefore, it is typically initiated once symptoms appear rather than as a preventive measure (44). The Effectiveness and practicality of non-pharmacological interventions for improving Behavioral and psychological symptoms of dementia are subject to conflicting evidence (45). While there is no definitive 'best practice' for bright light therapy in dementia, typical protocols involve using a rectangular light box with fluorescent bulbs covered by a diffusion screen administering 10,000 lux of full spectrum bright light for 30- 60 minutes in the morning, positioned at or above eye level 12- 18 inches away.

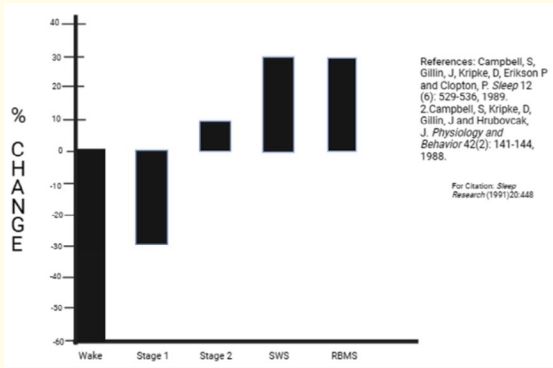

Figure 2: Shows the percentage change from baseline of sleep stage proportions following time exposure to bright light.

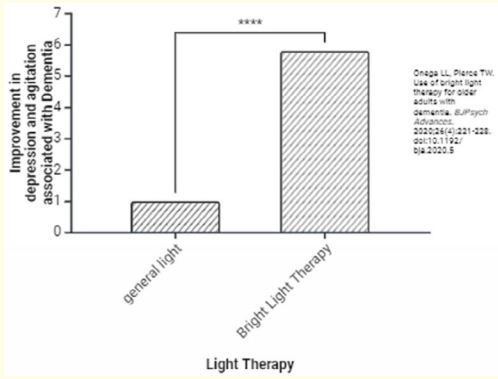

Figure 3: Improvement in depression and agitation associated with dementia.

A six-week, double-blind, placebo-controlled trial examined the impact of melatonin combined with bright light therapy. Bright light therapy sessions lasted for two weeks at 10,000 lux (2-5 days) and occurred between 8a.m and 11 a.m., where participants were instructed to gaze at light devices from 30 to 50 cm for 30 minutes (46). In a randomized controlled trial conducted by Gasio et al in Switzerland on dementia patients from nursing homes and psychiatric clinics, the effects of low intensity dawn-to-dusk simulation light therapy on sleep patterns, cognitive function and circadian rhythm were explored. Participants underwent a three-weeks period of baseline, treatment and follow-up wearing activity/lux monitors throughout (47).

Over a four-week period, participants (10 elderly patients with severe dementia) received bright light exposure (5000-8000 lux) for 45 minutes, typically between 8:00 am and 10:00 am under the supervision of nurses to make sure that the light source remained within 0.5m and patients did not close their eyes for extended periods (11). A cross over clinical trial conducted by Sloane et al in 2007 on dementia patients from two geriatric units investigated the effects of specialized lighting systems on sleep patterns. Three-week intervention periods studied morning, evening and all day-8.4 hours high intensity light patterns, with ambient bright light of approximately 2500 lux, gradually adjusting light intensity over 30 minutes using pre-programmed controls inaccessible to staff (42). In an 8-week randomized control trial by Burns et al (2007), participants received two-hour exposure to full spectrum bright light therapy

(10000 lux) for two hours between 10 am and 12 noon under the supervision of a nurse. BLT had a positive effect on mood and agitation (21). In another 4-week clinical trial on participants with Alzheimer disease from a nursing home in Albany, low intensity bluish white light was used and light-dark and rest-activity patterns were monitored using a Daysmeter. A timer was set to automatically activate all luminaires around set time usually between 6-8 am and turn them off at 6 pm (39). In a 12-week nonrandomized trial that took place at Silverado Senior Living Dementia Care community in Los Angeles, participants were exposed to daylight by engaging in social activities in the perimeter zone of a daylit room from 8:00 am to 10:00 am for 7 days per week (43). In a study conducted between September 2017 to April 2018 to assess the effects of BLT on sleep and circadian rhythms, ceiling-mounted LED panels were used emitting light at 1000lx between 10am and 3pm (38). In a study conducted by Jae Kim et al, a personalized light device emitting short wavelength radiation was used one hour per day for a period of two weeks (20).

In another double-blind randomized control trial, participants were exposed to blue-enriched light therapy for 60 minutes per session, with a total of 5 sessions per week over a period of 10 weeks which showed significant improvements in objective sleep parameters (48).

Adverse Effect of Bright Light Therapy

Eye Strain, nausea, insomnia and headache are the common side effects (49, 50). Studies conducted in individuals with mood-disorders reveal an increase in the attentional vigilance to negative information (51) and some studies show increased sensitivity to anticipatory pain (52). Studies conducted by Yevgeny Botanov and colleagues show the percentage of immediate adverse effects caused by bright white light and dim red light on the normal patients and results are summarized below.

Name Of Study	Light Source	Light Intesity	Duration	Timing	Results
Bright light therapy and melatonin in motor restless behaviour in dementia: a placebo-controlled study	Light Device(unspecified)	10,000 lux	30 minutes for 6 weeks with 1 week wash out period in between	Morning	Patients were less restless and more co-operative with bright light therapy.
Dawn-dusk simulation light therapy of disturbed circadian rest-activity cycles in demented elderly	Dawn Dusk Simulation Light Lamp	Low intesity DDS light	Averaged 1 hour per day for 3 weeks	Morning and Evening	The intervention group tended to have shortened 'sleep latency' , longer 'sleep duration', more nocturnal immobility and less nocturnal activity
Improvement in behavioral symptoms and advance of activity acrophase after short-term bright light treatment in severe dementia	Lamp	5000-8000 lux	45 minutes daily for 4 weeks	Morning	BLT is effective in reducing behavioral symptoms and aspects of activity rhythm disturbances in severe dementia
High-intensity environmental light in dementia: effect on sleep and activity	Low-glare lightning system installed in the building	2500 lux	2.5 to 3.0 hours for morning and evening groups and 8.4 hours for all day group	Morning and Evening	Night-time sleep increased significantly in participants exposed to morning and all-day light, with the increase most prominent in participants with severe or very severe dementia
Bright light therapy for agitation in dementia: a randomized controlled trial	Light Box	Full spectrum Bright light of 10,000 lux	2 hours per day for 8 weeks	Morning and Noon	Limited evidence of reduction in agitation in people on active treatment, sleep was improved and a suggestion of greater efficacy in the winter months
Tailored lighting intervention improves measures of sleep, depression, and agitation in persons with Alzheimer's disease and related dementia living in long-term care facilities	Bluish White light emitting Luminaire	300-400 lux	10-12 hours	Morning and Evening	Light intervention improved sleep quality and behaviour in patients with Alzheimer's Disease and related Dementia
Pilot study to examine the effects of indoor daylight exposure on depression and other neuropsychiatric symptoms in people living with dementia in long-term care communities	Daylit Room	Daylight	2 hours per day for 12 weeks	Morning	Increased exposure to daylight can reduce depression in patients with Dementia

The effects of bright light treatment on affective symptoms in people with dementia: a 24-week cluster randomized controlled trial	Ceiling mounted LED panel	1000 lux	4 to 5 hours per day for 24 weeks	Morning and Noon	In BLT intervention group, affective symptoms were reduced after 16 weeks suggesting BLT could be beneficial for patients with Dementia
Efficacy of Blue LED Phototherapy on Sleep Quality and Behavioral and Psychological Symptoms of Dementia: A Double-Blind Randomized Controlled Trial	Blue enriched light emitting LED	NR	60 minutes per day for 10 weeks	NR	Blue enriched light therapy showed significant improvents in objective sleep parameters like sleep efficiency, sleep latency and sleep quality
Effect of Personalized Blue-Enriched White Light Intervention on Rest-Activity and Light Exposure Rhythms in Mild and Moderate Alzheimer's Disease	Personalized light device	NR	1 hour per day for a period of 2 weeks	Morning and Evening	Personalized light intervention could be used to improve daily patterns of activity and light exposure of Alzheimer Disease patients

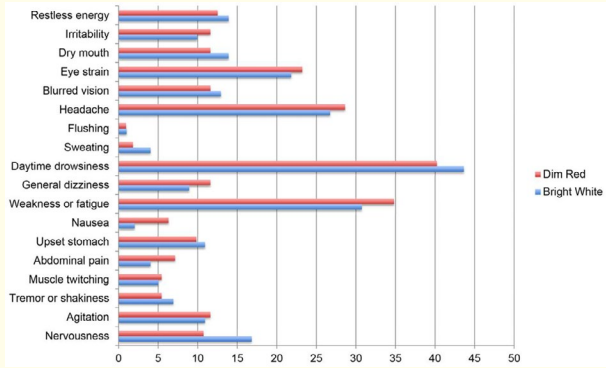

Figure 4: Common side effects observe during bright light therapy (69).

Adverse Effect/Safety Consideration	Description	Mitigation
Eye Strain and Discomfort	Eye strain and potential retinal damage from prolonged exposure.	Use protective eyewear and take breaks.
Sleep Disturbance	Disrupted sleep patterns if exposure is too close to bedtime.	Schedule sessions appropriately; consult a healthcare professional
Mania/Hypomania	Triggering manic/hypomanic episodes in bipolar individuals.	Close monitoring and parameter adjustments.
Skin Sensitivity	Sunburn-like symptoms with prolonged exposure.	Use sunscreen or protective clothing.
Interference with Medications	Adverse effects or reduced efficacy with certain drugs.	Review medication profiles before starting BLT.
Eye Damage	Risk of photokeratitis and cataracts from UV light.	Use proper eye protection.
Electrical Safety	Risk of electrical shock or fire from device misuse or damage.	Regular maintenance and follow manufacturer instructions.
Heat-related Issues	Discomfort or burns from device heat.	Ensure ventilation and avoid direct contact.

Table 1: Adverse Effect of Bright Light Therapy.

Keeping in view of the increasing use of both clinical and non-clinical usage of bright light therapy, it is necessary to conduct more clinical trials on the adverse effects of bright light therapy.

Comparative Efficacy of Bright light therapy

In a double blinded placebo controlled trial conducted by Haffmans et al (2001) where 10 patients with dementia and motor restless behavior, were exposed to 1000 lux of bright light and 2.5 gm of melatonin, it was observed that bright light therapy had a positive effect on motor restless behavior in dementia. They also observed that combining melatonin did not result in any significant improvement (46). Gasio et al (2003) conducted a randomized control trial on 13 elderly patients with dementia for a period of 3 weeks using low intensity Dawn-Dusk stimulation light and observed a reduction in sleep latency and increase in sleep duration (47). Skjerve et al (2004) exposed 10 elderly patients with severe dementia to 5000- 8000 Lux of bright light for 45 minutes each morning for 4 weeks and observed a significant improvement in behavioral symptoms. However, they did not observe any changes in sleep- wake measures (11). Sloane et al (2007) conducted a cluster unit crossover trial on 66 older adults with dementia. They exposed the patients to 2500 Lux of ambient light for 2.5 to 3 hours in the morning and evening and noted a significant increase in nighttime sleep duration while no significant effect on daytime sleepiness was observed (42). Burns et al (2009) in a randomized controlled trial on 48 patients (26 patients in control group and 22 patients in experimental group) observed that bright light therapy had a positive effect on mood and agitation specially during winter days but had no significant effect on sleep duration (21). Figurio et al (2014) conducted a clinical trial on 14 patients with Alzheimer's disease and related disorders. They noticed that low intensity bluish white light for 4 weeks improved circadian entertainment, mood and sleep quality in elderly patients with ADRD (39).

An interesting observation was made by Sekiguchi et al in 2017. They conducted a case series where they studied 17 patients with dementia (8 with Alzheimers, 4 with vascular dementia and 5 with lewy body dementia. It was observed that bright light therapy demonstrated an efficacy in alleviating sleep disturbance in Alzheimer's disease patients and not in patients with vascular dementia or Lewy body dementia (53). Konis et al (2018) included 77 patients with AD and ADRD in a non randomized cluster trial for 12 weeks where they were exposed to indoor daylight. They noticed an improvement in depression with just indoor light, but no significant effect was seen on neuropsychiatric symptoms (43). Figurio el al (2020) also studied 47 patients with AD and ADRD in a clinical trial for 25 weeks exposing them to circadian effective daylight treatment and observed significant improvements on sleep, depression and agitation (39). Cibera et al in 2021 conducted a randomized controlled trial on 39 adults with moderate to severe dementia where they were exposed to 10,000 units of bright light for 30 minutes in the morning for 4 weeks, 5 days a week and saw promising effects in mood but they noticed that BLT could temporarily affect speech (13). Koiberg et al. 2021 also conducted a similar RCT on 24 patients with mild to moderate Alzheimer's disease exposing them to 1000 lux for 24 weeks and noticed an improvement in affective symptoms (38). Kim et al (2023) conducted a RCT on 24 patients with mild- moderate Alzheimer's disease using personalized blue enriched white light for just 2 weeks and they also observed a noticeable decrease in daily rest activity patterns (20). Chen et al (2023) in a randomized controlled trial on 60 patients with dementia also saw a significant improvement in sleep quality and behavioral symptoms following 60-minute sessions of blue LED phototherapy for 10 weeks (48). Leishout et al (2023) in a randomized cross over trial on 10 people with a primary diagnosis of dementia with 4 phases of dynamic lighting system lasting for 4 weeks each also noted a significant improvement in agitation scores but no significant effect on sleep variables (54).

Factors Influencing effect of BLT on dementia

Various factors have been observed to influence the response to bright light therapy. Some of the factors influencing its effectiveness are light intensity, duration, timing, exposure patterns, dementia type, dementia severity, and acceptance of and adherence to the regimen (48).

Sr.	Study	Study Type	Study Population	Intervention	Duration	Positive Outcome	Negative Outcome	Key findings
1..	Haffmans et al. (2001)	Double blind placebo-controlled crossover trial.	10 patients with dementia and motor restless behaviour.	Bright light(10000 lux) and melatonin 2.5 gm	4 weeks with 1 week of washout period after 2 weeks.	Improvement in motor restless behaviour.	Melatonin showed no additional positive benefits	Bright light therapy had a positive effect on motor restless behaviour in dementia. . Melatonin in combination with bright light did not result in any improvement of motor restless behaviour in dementia.
2.	Gasio et al. (2003)	Randomized controlled trial	13 elderly patients with dementia	Low intensity dawn-dusk simulation(DDS) light	3 weeks	Reduction in sleep latency and increase in sleep duration	no significant effect on clinical or cognitive status..	DDS potentially improved sleep quality and timing in advanced dementia patients, suggesting responsiveness of the circadian system to such intervention.
3.	Skjerve et al. (2004)	Clinical Trial	10 elderly patients with severe dementia.	Bright Light (5000 to 8000 lux)	45 min each morning for 4 weeks.	Behavioural Symptoms improved.	No changes in sleep wake measures.	BLT showed improvement in behavioural symptoms but no significant changes in sleep disturbances or activity measures,
4.	Sloane et al. (2007)	Cluster unit cross-over trial	66 older adults with dementia.	Ambient bright light of approximately 2500 lux.	2.5 to 3 hours for morning and evening interventions and 8.4 hours for all day intervention.	Significant increase in night time sleep duration.	No significant effects on daytime sleepiness and overall strength of day	Exposure to morning and all-day light increased nighttime sleep duration, particularly in severe dementia cases, while effects on daytime sleepiness were inconsistent, and overall activity rhythm strength remained unchanged.
5.	Burns et al. (2009)	Randomized controlled trial	48 patients with dementia. 26 patients in the control group and 22 patients in the experimental group.	Bright light therapy.	8 weeks	Positive effect on mood and agitation	No effect on sleep and cognition..	BLT in dementia patients improved behavioural symptoms and reduced agitation, especially on winter days, but did not significantly affect sleep duration or depressive symptoms.
6.	Figuerio et al. (2014)	Clinical Trial	14 patients with Alzheimer's disease and related disorders.	Low level bluish white lighting aimed to deliver strong circadian stimulation.	4 weeks	Improved sleep efficiency and total sleep time.along with reduced depression and agitation score.		The lighting intervention improved circadian entrainment, sleep quality, and mood in elderly subjects with ADRD.
7.	Sekiguchi et al. (2017)	Case series.	17 patients with dementia (8 with AD, 4 with VaD, and 5 with DLB)	Bright light therapy.	1 hr/day for 2 weeks	Improvement in sleep disturbance in AD patients.	No significant improvement in sleep in VaD and LBD	Bright Light Therapy (BLT) demonstrated efficacy in alleviating sleep disturbance in Alzheimer's disease (AD) patients but not in those with vascular dementia (VaD) or dementia with Lewy bodies (DLB), particularly effective for AD patients with a Mini-Mental State Examination score >10.
8.	Konis et al. (2018)	Non randomized cluster trial	77 patients with Alzheimer's disease and related dementia.	Indoor daylight exposure.	12 weeks	Improvement in depression symptoms related to light exposure.	No significant correlation found between light exposure and neuropsychiatric symptoms.	Increased daylight exposure in dementia care communities correlates with reduced depression in Alzheimer's patients, indicating its potential therapeutic benefit.
9.	Figueiro et al. (2020)	Clinical Trial	47 patients with Alzheimer's disease and related dementias.	Circadian-effective daytime lightning	25 weeks.	Positive effects on sleep efficiency, reduction in depression and agitation		Circadian-effective daytime lighting in controlled environments improves sleep, reduces depression and agitation in dementia patients, with benefits increasing over time, promising enhanced well-being.
10.	Cibera et al. (2021)	Randomised controlled Trial	39 older adults with moderate to severe dementia.	Bright light (10000 lux).	30 min morning sessions,for 4 weeks, 5 days per week	Positive effects on mood and stimulation level	Decrease in speech	BLT showed promising effects on mood, stimulation, and physiological measures, but may temporarily affect speech.
11.	Koleberg et al. (2021)	Cluster randomized controlled trial	69 patients with dementia	Bright light (1000 lx and 6000 K)	24 weeks.	Improvement in affective symptoms.		the intervention had a positive effect on reducing depression and neuropsychiatric symptoms in patients with dementia.
12.	Jae Kim et al. (2023)	Randomized controlled trial	24 patients with mild to moderate Alzheimer's disease (n=10 in control group and n=14 in experimental group)	Personalised light using a blue-enriched light-emitting-diodes device	2 weeks.	Noticeable decrease in variability of daily rest and activity pattern	No significant effect on cognition	There was reduced variability in daily rest-activity patterns following personalised light intervention, while immediately after intervention, there was a tendency towards reduced variability in light exposure patterns.
13.	Chen et al. (2023)	Randomized controlled trial	60 elderly patients with dementia	Blue LED phototherapy.	60 min sessions for 10 weeks with 5	Improvement in sleep quality, and		Blue-enriched light therapy demonstrated significant improvements in objective sleep

					sessions per week	behavioural symptoms.		parameters, subjective sleep quality, and overall behavioural symptoms severity in dementia patients, with effects lasting up to 6 months, particularly in physical and verbal behavioural symptoms.
14.	Lieshout van-Dal et al. (2023)	Randomized cross-over trial	10 persons with primary diagnosis of dementia.	Dynamic lighting system	4 phases of 4 weeks each	Significant reduction in agitation scores.	No significant effect on sleep variables.	Dynamic light intervention did not improve sleep duration or depression and anxiety symptoms but significantly improved agitation.

Mode of light delivery

Certain studies delivered bright light using a rectangular light box with fluorescent bulbs covered by a diffusion screen (55, 56), whereas some other studies have used other methods such as ceiling-mounted lights (57). Both methods have yielded positive results and have shown a significant improvement of dementia symptoms, including improved sleep and decreased agitation (57). A recent study done by Leishout et al (2023) used a dynamic lighting system which is more suitable for older adults as it does not cause as much discomfort due to glare and blinding by light. Moreover, it allows free movement enabling continuing daily activities. Hence dynamic lighting is preferred over light boxes; however, it would be more difficult to use it at home because of cost and feasibility (54).

Duration of light therapy

It is our observation that when patients with dementia were exposed to BLT for a duration of at least 4 weeks, there has been a significant improvement in behavioral symptoms, mood and sleep disturbance (46, 11, 21, 39, 13, 38, 54). Dosing commonly used was 10,000 lux of bright white light for a duration of 30 min every morning (58). This schedule has been shown to be effective when administered 5 days a week with at least 80% adherence (47). However, studies done by Koieberg et al, Sloane et al, Skjerve et al have revealed that lower intensity light 1000 lux, 2500 lux, 5000-8000 lux have also had improvement in affective symptoms, nighttime sleep duration and behavioral symptoms but there was no significant improvement on day time sleepiness and sleep wake measures at this intensity (38, 42, 11). Lower intensities may need longer exposure durations 2,500 Lux for 2 h/day, 5,000 Lux for 1 h/day (59).

Type of light

The use of narrow-band blue light is equally effective as a treatment when compared to using bright white-light (60). Chen et al 2023 and Figuerio et al 2014 used blue LED phototherapy and low level bluish white lighting and observed an improvement in sleep quality, total sleep time and sleep efficiency in patients with dementia (48, 39)

Type of dementia

A study done by Sekiguchi et al 2017 revealed that BLT resulted in a significant improvement in sleep among AD patients, but no significant improvement was seen in patients with vascular dementia and Lewy body dementia (53). Individuals with severe dementia also had an increase in negative effects. Cibera et al noticed that BLT temporarily affected speech in patients with severe dementia (13).

Deterrents to BLT

Some other factors that could deter the use of BLT could be associated with the side effects of BLT. Although better tolerated when compared to pharmacotherapy, BLT is associated with side effects like headache, eye irritation, glare irritability, restlessness and over activity (61). These symptoms could be significantly reduced with dynamic light therapy (54). Light therapy, like other antidepressants, may be associated with a switch to hypomania or mania in vulnerable bipolar patients (13).

Adherence to therapy

During the sessions, while exposed to light, participants watched documentaries on neutral topics (13) which improved adherence.

Social acceptance of BLT

Studies conducted on patients with seasonal affective disorder to observe the social acceptance of bright light wearable devices. The results showed that patients were receptive to all kinds of wearable devices (62).

Conclusion

A total of 14 studies were reviewed, each of which has shown mostly positive outcomes with BLT on patients with dementia. 6 studies showed an improvement in sleep quality (12, 39, 47, 43, 53, 48), 2 studies showed improvement in behavioral symptoms (11, 46), 3 studies revealed a reduction in agitation scores (12, 21, 54), 2 studies showed reduction in depression (48, 39) and 2 studies showed improvement of mood symptoms (11, 21). Studies done by Konis et al and Figuerio et al (43, 39) used daylight which is different from BLT and have also shown an improvement in symptoms of depression.

A study done by Skjerve et al did not show any improvement in sleep disturbances but that could be because it was conducted among patients with severe dementia and also because they used lower intensity light (5000- 8000 Lux) (11).

The above studies reveal a clear potential of lighting systems in treating circadian rhythm disorders, thus improving quality of life for people with dementia. Challenges are the above studies show heterogeneity in terms of sample population, and the timing and duration of light. Most studies have also not controlled seasonality which could be a potential confounder (71). In conclusion behavioral and psychological symptoms associated with dementia can be treated with light therapy when properly designed and implemented.

Future directions and research opportunities

Despite several studies showing the benefits of BLT, we need more research on how to reliably and validly develop precise clinical guidelines on the exact use of light interventions.

Most of the above studies have been done in institutions and very few have been conducted at home. Light therapy administered at home is tricky to quantify because every house is different in terms of the amount of light entering the home, the number of windows, the use of curtains and various other architectural differences between homes. However, if we are able to safely identify ways to administer BLT to patients suffering from dementia it would be an extremely cost effective, safe and effective way to address sleep and psychological symptoms in older adults with dementia and it would be so much safer than pharmacotherapy which is associated with various concerning side effects, especially falls.

Recommendations

Lifestyle Changes: People with dementia tend to spend more time indoors than outdoors. Exposing these patients to daylight is a simple intervention that could itself have a significant impact on their sleep wake cycle.

Standardize Procedures: Numerous protocols for bright light therapy have been used and varying results have been observed. Standardizing BLT procedures (type, duration and timing could ensure uniform application.

Individualize Treatment: Although standardized procedures are good, tailoring therapy based on specific needs of patients might be required. Dynamic light therapy would be a good option to treat patients living at home.

Implement BLT Programs: We believe that health care facilities could definitely benefit from implementing bright light therapy programs for dementia management.

Conduct Further Research: Further research is required on the long-term efficacy and advantages of BLT in the treatment of dementia.

Educate and Raise Awareness: Raising awareness about the efficacy of BLT and promoting its use among the elderly population in

private residences as well as in assisted living facilities could have a significant impact in management of dementia.

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