SECTION 2:
Light Treatment

Section Editor: *Raymond W. Lam*
Section Authors: *Raymond W. Lam, Edwin M. Tam, Christopher P. Gorman, Carl Blashko, Rudradeo C. Bowen, Rachel L. Morehouse, and Gary Hasey*

What is light therapy?

Light therapy, also called light treatment or phototherapy, involves daily scheduled exposure to bright artificial light. The term "light therapy" is used by consensus in the field to differentiate light therapy for SAD from phototherapy for other conditions, such as hyperbilirubinemia or psoriasis. The initial use of light therapy in psychiatry arose from circadian rhythm hypotheses for seasonal and nonseasonal depression (Kripke, 1981). It was known that exposure to room light (less than 500 lux, a unit of illumination intensity) could alter circadian rhythms in animals and that manipulating the daily light-dark cycle, or photoperiod, could change many seasonal behaviours. These effects were often mediated through light-induced suppression of nocturnal melatonin secretion. Room light, however, did not seem to have the same circadian or melatonin-suppressing effects in humans. Researchers then discovered that suppression of human melatonin generally requires much higher intensities of light (greater than 2,000 lux) than those for animals (Lewy et al., 1980). A patient who experienced recurrent winter depressive episodes was seen as analogous to an animal whose seasonal behaviours were linked to the shorter winter photoperiod, prompting the use of bright light to extend the photoperiod (Lewy et al., 1982). The successful treatment of this patient led to the first systematic description of SAD and the first controlled study of light therapy by Rosenthal and colleagues (1984a). In that study, a large bank of fluorescent light tubes was used to expose the patients to 2,500 lux white light for three hours in the morning and three hours in the evening, to simulate the longer summer photoperiod. Dim (500 lux) yellow light was used as the control condition in a crossover study design. The results were impressive: seven of nine patients had a marked response within one week with the bright-light condition, compared to one of nine with the dim light.

Is light therapy an effective treatment for SAD?

Since the first study of light therapy in SAD (Rosenthal et al., 1984a), there have been more than 60 controlled studies published by researchers around the world. The fluorescent light box is the most studied light device, with more than 40 studies using similar fluorescent light boxes. Many studies with fluorescent light boxes have shown superiority against a number of different placebo controls, although each individual study can be criticized for the type of placebo used, the relatively small sample sizes (usually fewer than 15 patients per condition), and the short treatment periods (usually one to two weeks). Despite these limitations, the multiple replications of positive results by independent research groups provide some assurance of efficacy. Several qualitative reviews of the literature (e.g., Blehar and Lewy, 1990; Lam et al., 1989b; Rosenthal et al., 1988b; Tam et al., 1995; Wesson and Levitt, 1998) have concluded that light therapy, administered by fluorescent light boxes with illumination exposures of greater than 2,500 lux, is an effective treatment for SAD, with response rates of 60% to 90%. Additionally, two quantitative meta-analyses of fluorescent light boxes (Lee, 1995; Terman et al., 1989b) have demonstrated significant superiority of bright-light boxes over putative placebo conditions (usually dim-light conditions). Another meta-analysis, conducted under the rigorous procedures of the Cochrane Collaboration (Chalmers, 1993), also confirmed that bright-light boxes are superior to dim-light conditions (Thompson et al., 1999). Finally, two recent large-sample studies have shown smaller effect sizes (i.e., standardized differences between conditions) but clear superiority in rates of clinical response of fluorescent light boxes over plausible placebo control conditions (inactivated or low-density negative ion generators) (Eastman et al., 1998; Terman et al., 1998). Large case series suggest that about 65% of patients with SAD have a good clinical response to bright-light therapy (Lam et al., 1997b).

What light devices are available?

Published studies have utilized various light devices for light therapy, including fluorescent light boxes, a light box using incandescent light, a portable and flexible fluorescent "light lamp," an incandescent head-mounted unit or "light visor," a head-mounted unit using a red LED or "light cap," and a "dawn simulator" device.

The fluorescent light box is the "gold standard" device for light therapy, with reasonable Level 1 evidence for clinical efficacy. The efficacy of other light devices, however, is less clear. A head-mounted unit, the

incandescent light visor, ranks with fluorescent light boxes as well-studied devices in light therapy. Each of three studies used a very similar light visor, and these studies had larger sample sizes than any single light-box study (Joffe et al., 1993; Rosenthal et al., 1993; Teicher et al., 1995). The visor studies have the added benefit of multicentre designs, which usually enhance generalizability of the results. The effect sizes (i.e., standardized differences between pre- and posttreatment) and response rates of the light visors were large and comparable to light-box studies. However, the results are problematic because the putative placebo conditions in the light-visor studies, consisting of very dim light (30 to 60 lux), also led to good responses, and there were no differences between the dim-light and bright-light conditions. The possible explanations for these findings are that (1) the light visors are no more effective than placebo conditions, (2) the placebo responses in these studies are considerably higher than the light-box studies, or (3) the dim lights are not suitable placebo controls for light visors. Of note for the third possibility is that even dim light of less than 100 lux can produce biological effects such as melatonin suppression under certain conditions (Brainard, 1998).

The red LED light cap was used in two studies. One had a reasonable sample size (43 patients in two conditions) (Levitt et al., 1994), whereas the other had smaller samples in each condition tested (Levitt et al., 1996). Again, although response rates were good, and comparable to light-box studies, there was no differentiation between any active light condition with any putative control. Even a "no light" condition did as well as the bright-light box in the smaller sample study. Therefore, as with the light visor, efficacy has not yet been demonstrated for the light cap. The results of these studies were summarized in a meta-analysis that showed no evidence of effectiveness for head-mounted units (Thompson et al., 1999).

Dawn simulation is a technique used to simulate the effects of a summer dawn during the winter by gradually increasing ambient light while patients are sleeping (Terman et al., 1989a). Compared with light therapy, dawn simulation uses much lower light intensities, and the light is administered while patients are sleeping (with their eyes closed). Dawn simulation using a maximum illumination of 250 lux was shown in two small parallel studies to be superior to very-dim-light conditions (less than two lux) (Avery et al., 1993, 1994). However, another study by the same group showed no difference between a gradual and a rapid 275 lux dawn (Avery et al., 1992b). Thus, it remains unclear whether

the gradual ramping of the light intensity is actually necessary. A recent study also found that bright-light therapy for six days was superior to dawn simulation for two weeks (Lingjaerde et al., 1998).

Although clinical efficacy has not been conclusively demonstrated for these other light devices, the clinical response rates for head-mounted units and dawn simulators may be similar to those for other treatments for SAD. The panel consensus was that some patients may benefit from these devices, though they were not recommended. For example, in situations in which patients require greater portability than that afforded by light boxes, head-mounted units or dawn simulators may be considered for treatment.

Recommendations: Light Devices

(1) Light therapy is an effective first-line treatment for seasonal affective disorder. [Level 1 evidence]
(2) The fluorescent light box, with light intensities of greater than 2,500 lux, is the preferred device for light therapy. [Level 1 evidence]
(3) Some patients may respond to other light devices, such as head-mounted units and dawn simulators. [Level 5 evidence]

What are the relevant parameters of light therapy?

The four basic parameters commonly used to describe light therapy are intensity, wavelength, duration of daily exposure, and timing of light exposure. Intensity is usually expressed in lux, a photometric unit of illuminance that corrects for the visual spectral responsiveness of the eye. As references, living room evening lighting is usually less than 100 lux, bright office lighting is in the order of 300 lux to 500 lux, outdoors on a cloudy day ranges from 1,000 lux to 5,000 lux, and direct midday sunlight can reach 50,000 lux or higher. Lux has been shown to have relevance in studies of light on circadian rhythms and other biological parameters (e.g., light suppression of nocturnal melatonin secretion). Nonetheless, there is still controversy about whether a photometric unit is the best measure of the biological and therapeutic effects of light. Other possibilities include the use of radiometric measures such as irradiance and quantum density, which are based exclusively on the physical properties of light (Brainard, 1998). The "dose" of light can also be varied by changing the daily duration of exposure. However,

there are practical limits to the amount of time used for light therapy, given that the treatment requires sitting in front of a light box.

Until recently, the biological effects of light on the human circadian system were thought to be mediated solely through the eyes. A well-established neural pathway, the retinohypothalamic tract, connects the retinas with the suprachiasmatic nucleus of the hypothalamus, the site of the biological pacemaker. Similarly, one small study found that the antidepressant effects of light therapy were apparent with eye exposure but not skin exposure (Wehr et al., 1987b). However, a recent report suggests that transdermal light exposure can alter human circadian rhythms (Campbell et al., 1998). This finding raises the possibility that light exposure through the skin may also be relevant to the antidepressant response of light therapy for SAD.

What "dose" of light therapy should be used?

In terms of intensity, most controlled studies with light boxes have compared bright light (greater than 2,000 lux) to a dim-light (less than 500 lux) control condition. Most have shown superiority of bright light (Isaacs et al., 1988; James et al., 1985; Magnusson and Kristbjarnarson, 1991; Rosenthal et al., 1984a; Rosenthal et al., 1985; Winton et al., 1989), although some have not (Grota et al., 1989; Wirz-Justice et al., 1986). Analysis of pooled results shows clear evidence of greater efficacy with bright light (Lee 1995; Terman et al., 1989b). Other studies have compared bright light (5,000 lux to 10,000 lux) to a nonlight placebo control. Although two smaller studies found no difference (Eastman et al., 1992; Levitt et al., 1996), two larger studies showed superiority of the bright light over the placebo condition (Eastman et al., 1998; Terman et al., 1998).

Within the bright-light range, a meta-analysis also suggested that high-intensity light (6,000 lux to 10,000 lux) was superior to medium-intensity light (1,700 lux to 3,500 lux), which in turn was superior to low-intensity light (1,000 lux or less) (Lee, 1995). One direct comparison found 10,000 lux to be superior to 3,000 lux using 30 minutes of daily exposure (Terman and Terman, 1990c).

In terms of daily duration of light exposure, the majority of studies used 2,500 lux light that was usually administered for two to six hours per day. Comparisons of different treatment durations have shown some evidence of a dose-response relationship in that two hours and one hour of daily exposure were superior to half an hour (Wirz-Justice et al., 1986b).

However, superiority of four or six hours compared with two hours is not consistently shown (Doghramji et al., 1990; Winton et al., 1989).

Follow-up studies have shown that compliance with light therapy protocols involving two or more hours per day of treatment is poor (Schwartz et al., 1996). One study found that one hour of 2,500 lux was as effective as two hours (Wirz-Justice et al., 1986b). However, other studies have used higher-intensity light for shorter daily treatment durations. Studies of 10,000 lux fluorescent light given for 30 minutes per day produced similar results to protocols using 2,500 lux for two hours (Magnusson et al., 1991; Terman et al., 1990a). The 10,000 lux fluorescent light box has thus become the standard in clinical practice. There are no studies comparing other levels of illumination, so it is not known whether there is a linear relationship between intensity and duration for effective light therapy.

Moreover, lux, as a measure of illuminance, varies as the inverse square of the distance to the light source. Because the lux level drops precipitously with increasing distance, it is vital to properly position the patient in relation to the light source, to ensure that the proper "dose" of light is given. Gazing at the light source is not necessary or recommended. Patients can read or work under the lights if they are properly positioned.

Should light therapy be given in the morning, evening, or both?

There has been an ongoing debate regarding the optimal timing of light therapy. The original theoretical model of SAD was based on studies of seasonal changes in animals, which are mediated through changes in circadian rhythm and photoperiod. Light therapy was administered both morning and evening in order to lengthen the winter day and simulate a summer photoperiod (Isaacs et al., 1988; Rosenthal et al., 1984; Rosenthal et al., 1985; Winton et al., 1989; Wirz-Justice et al., 1986). However, circadian changes have not been consistently associated with therapeutic effects, and twice-daily dosing may not be a crucial factor (Wirz-Justice et al., 1993). Issues of practicality and compliance favour once-a-day dosing. One meta-analysis showed some superiority of twice-a-day exposure over morning or evening alone (Lee et al., 1997a), but that study did not account for the different intensities of light used in the studies of daily timing. Another grouped analysis did not find any superiority of morning plus evening light over morning light alone (Terman et al., 1989b).

In terms of optimal timing of a single dose of light, many studies have found morning light exposure superior to evening light exposure (Avery et al., 1990a, b; Avery et al., 1991; Eastman et al., 1998; Lewy et al., 1987a; Lewy et al., 1998b; Sack et al., 1990; Terman et al., 1990c; Terman et al., 1998), whereas others have found no difference (Hellekson et al., 1986; Jacobsen et al., 1987; Lafer et al., 1994; Meesters et al., 1995; Wirz-Justice et al., 1993). No controlled study has found evening light exposure to be superior. Light exposure during the late evening may also cause insomnia. An analysis of pooled results from 29 earlier studies showed some superiority of morning light over evening light (Terman et al., 1989b). There was initial concern that studies with crossover designs favoured morning light because of a sequencing effect, but recent large-sample, controlled, parallel-design studies have confirmed superiority of morning light exposure for SAD (Eastman et al., 1998; Lewy et al., 1998b; Terman et al., 1998). Although morning light was found superior to evening light, evening light exposure was also significantly superior to placebo (Eastman et al., 1998; Terman et al., 1998). A rigorous meta-analysis also showed superiority of morning light over light at other times of the day (Thompson et al., 1999).

What wavelength of light should be used?

The optimal wavelength for therapeutic effect of light therapy has been explored based on evidence that maximum melatonin suppression is attained with green light near 509 nm (Brainard, 1998) and given the adverse effects of ultraviolet light on the eye and skin. Comparisons of colour (wavelength) have shown some superiority of green light over red light (Oren et al., 1991a) and white light over blue and red light (Brainard et al., 1990) and over green light (Stewart et al., 1991), although the results were limited by complex interactions of order of treatment. These findings, however, were generally supported by a meta-analysis showing that short wavelengths (blue, green, yellow) were superior to red light (Lee et al., 1997b), although that analysis did not control for different duration or intensity of light treatment. The panel consensus was that white light is recommended for light therapy.

Both broad-spectrum ("full spectrum") fluorescent light and cool-white fluorescent light seem to be equally effective (Bielski et al., 1992). Although an initial study found bright fluorescent light with ultraviolet wavelengths to have some benefit over bright light with the ultraviolet blocked (Lam et al., 1991b), a larger follow-up study showed both to be equally effective (Lam et al., 1992b).

What constitutes an adequate length of time for a trial of light therapy?

Response to light therapy generally occurs within two to four days, and measurable improvement is often seen in one week. Most of the initial studies used one-week treatment periods because statistically significant improvement could be noted within that time. Similarly, most patients (but not necessarily all) experience recurrence of symptoms after discontinuing light therapy, within the same time period. Such rapid response and relapse have enabled studies with crossover designs, in which different treatments are applied to the same patient over an extended period of time.

Even though many patients show a clinical response at one week, the response rate increases after two weeks of light therapy (Labbate et al., 1995). The few studies with treatment for more than two weeks also show incremental increases in response rate at three weeks to five weeks (Bauer et al., 1994; Eastman et al., 1998; Ruhrmann et al., 1998). Thus, the length of time for an adequate trial of light therapy should be two to four weeks. More gradual improvement, especially later in the winter season, may indicate nonspecific spontaneous remission and may not be due specifically to light treatment.

Are there predictors of outcome for light therapy?

Several studies have shown that atypical symptoms such as hypersomnia, increased appetite, weight gain (Lam, 1994a; Nagayama et al., 1991; Oren et al., 1992), increased consumption of carbohydrates (Krauchi et al., 1993), and younger age (Lam, 1994a) are associated with good response to light therapy. Similarly, an atypical balance score (the score on the eight "atypical symptom" items on the SIGH-SAD, divided by the total SIGH-SAD score) was found to predict response to light therapy in SAD (Terman et al., 1996).

The presence of a personality disorder may also be associated with a poorer treatment outcome (as is the case in nonseasonal depression). Reichborn-Kjennerud et al. (1996) found that five of eight (63%) of the SAD patients who did not respond to light were also diagnosed with avoidant personality disorder (versus 1 of 18 [6%] of responders), and the presence of any DSM-III-R personality disorder was significantly associated with a poor response. Practically, however, the high prevalence of personality disorder decreases the prognostic value of these diagnoses in the individual SAD patient for whom light therapy is being contemplated.

How do patients obtain light devices?

Commercial light boxes and other light devices are now widely available without prescription in medical supply stores and via mail order. Patients are cautioned against constructing their own light boxes because of the electrical hazards, the difficulty in determining light intensity, and the size of the light box required. Because the industry is not regulated, the usual *caveat emptor,* or "let the buyer beware," applies to the purchase of a light device. Vendors should market light devices that meet electrical safety standards (Canadian Standards Association or US Underwriters Laboratory) and that have been tested in reputable clinical trials. The intensity should be specified for a particular distance from the light source, and the light device should be constructed with a filter for ultraviolet wavelengths.

Many vendors have a short-term rental program with rent applied to purchase price, and others have a 30-day return policy. These programs allow patients to determine whether they will respond to light therapy before purchasing a light device. Some clinics and clinicians purchase light boxes to lend to patients, again to determine whether they will respond to light therapy before buying a light box. The cost of a light box ranges from CDN$300 to CDN$500.

What practical tips are there for using light therapy?

Most patients use the light box at home while reading or watching television. Others use light therapy at work, setting up, for example, a light box by their computers or on their desks. Some hospitals and clinics have set up "light rooms" where patients can go to receive light therapy, but these rooms require daily visits to the clinic and are obviously less convenient than a light box at home or work.

Because of the rapid rates of response and relapse with light therapy, patients can become involved as active participants in determining the optimal dose of light. For example, if patients respond to early morning light exposure, but the time is inconvenient for them, they can try shifting the exposure to other times of the day. Similarly, if they respond to 30 minutes of light exposure, they may be able to maintain their responses with 15 minutes of light therapy per day. Or some patients are able to maintain their responses by using light therapy on weekdays. Patients should be advised to make one change at a time and to allow a week or two to assess the effects of a change.

There are many misconceptions about light therapy that often need to be addressed with patients. It is very difficult to raise the level of

illumination in a room to more than 600 lux, so it is not possible to treat SAD simply by increasing room lighting. A special type of light source is not necessary to treat SAD, as light intensity appears to be the critical factor. Tanning salons have never been investigated as a treatment for SAD. However, tanning should not be used to treat SAD because the antidepressant effects of light are thought to be mediated through the open eyes and not through skin exposure, the ultraviolet wavelengths are not necessary for the antidepressant effects, and there are risks associated with long-term exposure to ultraviolet light (e.g., cataracts).

What are the side effects of light therapy?

The common side effects of light therapy reported by patients include headache, eye strain, and agitation or feeling "wired" (see Table 5). These side effects are generally mild and do not appear to be related to light intensity. It is uncommon for patients to discontinue treatment because of side effects, which often subside with time or a decreased dose of light. Hypomania and mania have also been reported as uncommon but serious side effects of light therapy (Bauer et al., 1994; Chan et al., 1994; Levitt et al., 1993b). Because these reactions may be more common in bipolar disorder, patients with bipolar disorder, type I (those with previous manic episodes), should be treated with mood-stabilizing medications and monitored closely during light therapy.

Can light therapy produce ocular damage?

Bright-light treatment can theoretically lead to changes in the eyes and retinas, through either ultraviolet or visible-spectrum exposure. Although fluorescent lighting emits little in the ultraviolet wavelengths, the output is not negligible. Estimates for recurrent daily use of a fluorescent light box (without an ultraviolet filter) during the winter, over 20 years, can lead to lifetime ultraviolet exposures in the toxic range (Oren et al., 1990; Reme et al., 1996). Since ultraviolet exposure can lead to ocular and skin damage, and since the ultraviolet wavelengths do not add to the antidepressant effects of light therapy (Lam et al., 1992b), an ultraviolet filter is recommended for all commercial light devices.

In animals, the visible spectrum can lead to retinal damage under certain conditions of sustained exposure. The retina is especially sensitive to light in the blue wavelengths, the so-called blue-light hazard. Light-induced damage may also be potentiated by preexisting retinal disease or by medications that increase retinal sensitivity to light (Reme et al., 1996; Terman et al., 1990b).

Table 5

Reported side effects of light therapy for SAD

Study:	Kogan and Guilford (1998)	Labbate et al. (1994)	Levitt et al. (1993b)
Light therapy method:	10,000 lux fluorescent light box x 30 min/day x 5 days, *n* = 70	2,500 lux fluorescent light box x 2 hrs/day x 2 weeks, *n* = 30	60, 600, or 3,500 lux incandescent light visor x 30 min/day x 2 weeks, *n* = 105
Side effect:			
Headache	21%	13%	19%
Eye or vision problem	19%	27%	17%
Nausea or vomiting	7%	–	13%
Hypomania or agitation	6%	13%	–
Sedation	6%	7%	4%
Dizziness	3%	–	11%
Anxiety/"feeling wired"	3%	–	14%
Irritability	1%	–	–
Tightness in chest	1%	–	–
Sleep disturbance	–	13%	10%
Sweating	–	7%	2%
Palpitations	–	3%	–
Rash	–	1%	–
Muscle pains	–	–	10%
Abdominal pain	–	–	5%

These conditions would rarely be encountered in usual clinical use of light therapy, and 10,000 lux fluorescent light is regarded as relatively safe. Incandescent halogen lights have a greater risk of blue-light hazard with direct gazing (which is why halogen light fixtures are designed for indirect illumination) and should be avoided in commercial light devices, unless special diffusers are used. There are isolated reports of ocular damage during light therapy (Gallenga et al., 1997; Vanselow et al., 1991). However, two studies with five-year follow-up periods showed that chronic use of light therapy does not lead to any ophthalmological change or damage (Gallin et al., 1995; Gorman et al., 1993).

What ophthalmological screening should be done in patients prescribed light therapy?

The potential risks of bright-light therapy must be balanced against the inconvenience and cost of obtaining routine ophthalmological consultation and the measurable risks of repeated bright-light ophthalmological examinations such as indirect ophthalmoscopy and slit-lamp examination.

All patients considering light therapy should be asked about previous eye conditions or retinal disease. The following patients should be referred for baseline ophthalmological examination (including visual acuity, intraocular pressure, indirect ophthalmoscopy, and slit-lamp examination) and periodic monitoring:

(1) patients with preexisting retinal disease (e.g., retinal detachments, retinitis pigmentosa) or eye disease (e.g., glaucoma);
(2) patients with systemic illnesses that affect the retina (e.g., diabetes mellitus, systemic lupus erythematosis);
(3) patients with cataract surgery and lens removal;
(4) patients taking medications that have photosensitizing effects in humans:
    - lithium
    - phenothiazines such as thioridazine (antipsychotics, antiemetics)
    - chloroquine (antimalarial)
    - hematoporphyrins (used in photodynamic therapy for cancer)
    - 8-methoxypsoralen (used in ultraviolet treatment for psoriasis)
    - melatonin
    - hypericum (St. John's Wort)
    - (*Note:* animal studies show retinal changes with drugs, including beta blockers, tricyclic antidepressants, and tryptophan. The panel consensus was that ophthalmological assessment for patients on these drugs is not required unless patients have other risk factors.);
(5) elderly patients, who have a greater risk of age-related macular degeneration, which may be asymptomatic.

There are no absolute contraindications to light therapy. However, using light therapy in higher-risk individuals requires assessment of the risk-benefit ratio for each patient. For example, if a patient with retinitis pigmentosa is sensitive or intolerant to antidepressants, then light therapy can be considered with close ophthalmological monitoring.

Recommendations: Parameters for Light Therapy

(1) The starting "dose" for light therapy using a fluorescent light box is 10,000 lux for 30 minutes per day. [Level 1 evidence]
(2) Alternatively, light boxes emitting 2,500 lux require one to two hours of exposure per day. [Level 1 evidence]
(3) Correct positioning is important for the proper dose of light: i.e., sitting close enough to the light box to obtain the correct illumination. Patients should avoid looking directly into the light, as doing so may increase eye discomfort with no added benefit. [Level 3 evidence]
(4) Light boxes should use white, fluorescent light with the ultraviolet wavelengths filtered out. [Level 2 evidence]
(5) Patients should be cautioned against using incandescent halogen lights, since they may have a greater "blue-light hazard" with direct gazing. [Level 5 evidence]
(6) Light therapy should be started in the early morning, on awakening, to maximize treatment response, but exposure at other times of the day may be effective for some patients. [Level 1 evidence]
(7) Response to light therapy often occurs within one week, but some patients require two to four weeks to show a response. [Level 2 evidence]
(8) Patients can be encouraged to become active participants in establishing an optimal light protocol. [Level 5 evidence]
(9) Common side effects of light therapy include headache, eye strain, nausea, and agitation, but these effects are generally mild and transient or are resolved with a reduction in the dose of light. [Level 2 evidence]
(10) There are no absolute contraindications to light therapy, and there is no evidence that light therapy is associated with ocular or retinal damage. [Level 3 evidence]
(11) Patients with ocular risk factors should have a baseline ophthalmological consultation prior to starting light therapy, and periodic monitoring is warranted. [Level 5 evidence]

Can light therapy be used in children?

SAD has been described in children and adolescents (Carskadon and Acebo, 1993; Giedd et al., 1998; Glod et al., 1997; Rosenthal et al., 1986a; Swedo et al., 1995), so there is interest in using light therapy for these

groups. There are several case series of open light treatment showing beneficial effects of light in pediatric age groups (Cooke and Thompson, 1998; Giedd et al., 1998; Meesters, 1995; Rosenthal et al., 1986a). Two placebo-controlled studies have been published. Sonis et al. (1987) compared light therapy and relaxation therapy in 19 children in four diagnostic groups, including five children with SAD. Only the SAD group improved with light therapy and relapsed with relaxation therapy. Swedo et al. (1997) studied 28 SAD patients, aged seven to 17 years, and found that one hour of bright light plus dawn simulation were superior to a placebo condition. Although the studies have small sample sizes, the positive results are encouraging evidence that light therapy may be effective for pediatric SAD.

How does light therapy affect people without SAD?

No mood effects were found in normal subjects exposed to light therapy (Kasper et al., 1988, 1989a, 1990b; Rosenthal et al., 1987b). However, a longer study of light therapy found some suggestion of increased mood in normal subjects (Bauer et al., 1994). Bright light also has effects on the human circadian system independent of any effects on mood (see section below).

Some people have been identified as having "subsyndromal SAD": that is, they have many of the vegetative symptoms of SAD but do not meet the criteria for a major depressive disorder. In small-sample studies, light therapy was found beneficial for people with subsyndromal SAD (Kasper et al., 1988, 1989b; Norden and Avery, 1993). Since the prevalence of subsyndromal SAD is likely higher than that of SAD (11% to 25% in studies), more research about the effectiveness of light therapy in this condition is important.

Is light therapy effective for nonseasonal depression?

Before light therapy was known to be effective in treating SAD, it was investigated as a treatment for nonseasonal depression, to test a hypothesis of phase-advanced circadian rhythms in melancholic depression (Kripke, 1981). There have been fewer controlled studies of light therapy in nonseasonal depression than in SAD. An open trial of hospitalized depressed patients found benefits with light therapy (Wirz-Justice et al., 1999). A recent review (Kripke, 1998) indicated that there are more studies showing significant positive effects of light therapy (Kripke et al., 1992; Yamada et al., 1995; Yerevanian et al., 1986) than studies showing no effects (Mackert et al., 1991; Thalen et al., 1995b).

However, the clinical responses in nonseasonal depression have not been as dramatic as those seen in SAD. Differences in recruitment of patients, severity of depressions, and patient expectations may explain the smaller effect sizes seen in studies of light therapy for nonseasonal depression. Comparison with antidepressant studies in nonseasonal depression is difficult because the light therapy studies have had short treatment periods, usually one to four weeks. Further study to determine which patients are likely to respond to light therapy is necessary before it can be recommended as a sole treatment for nonseasonal depression. Light therapy may also prove useful as an augmentation of or combination strategy for refractory nonseasonal depression (Kripke, 1998; Levitt et al., 1991) or to prolong the antidepressant effect of sleep deprivation (Neumeister et al., 1996).

What other psychiatric disorders can be treated with light therapy?

Light therapy has been studied for a number of other psychiatric disorders, including bulimia nervosa, panic disorder, premenstrual depressive disorders, behavioural disorders in dementia, alcoholism, and obsessive-compulsive disorders. A recent book summarized the research and clinical studies in these and other areas, including nonseasonal depression, circadian sleep disorders, jet lag, and shift work (Lam, 1998a).

In general, these studies have small sample sizes and provide encouraging results. However, there is as yet insufficient evidence to recommend light therapy as a sole treatment for these disorders. It may be useful, however, as adjunctive treatment in these conditions. It may be particularly beneficial for patients who have seasonal exacerbations of a non-SAD disorder, such as seasonal bulimia nervosa (Lam and Goldner, 1998).

How can light therapy be used to treat other circadian disorders?

Light is one of the strongest zeitgebers (synchronizers) of the circadian rhythm system, and bright light can reliably shift human circadian rhythms. Light therapy has thus been used to treat conditions associated with disruptions of circadian rhythms, including jet lag, shift work, and circadian sleep disorders. A joint task force of the American Sleep Disorders Association and the Society for Light Treatment and Biological Rhythms published a consensus report on the use of light for treating sleep disorders in a theme issue of the *Journal of Biological Rhythms* (Terman et al., 1995b). Using light to treat these conditions is complex because of the intricate effects of timing of light exposure on the circadian

system. For example, light in the early morning leads to a phase advance of circadian rhythms and therefore corrects a delayed sleep phase disorder (e.g., Rosenthal et al., 1990). However, evening bright-light exposure can lead to a significant phase delay and thus counteract the effects of morning light. In these conditions, it is important not only to properly time the exposure to bright light to shift circadian rhythms in a desired direction but also to *avoid* bright light at other times in the circadian cycle that can worsen symptoms. Studies of jet lag and shift work are preliminary (reviewed in Boulos, 1998).

The cognitively impaired individual (e.g., with dementias including Alzheimer's disease) may be susceptible to weakened circadian rhythms of sleep and wakefulness due to degeneration of the SCN (Swaab et al., 1985). Behavioural disturbances resulting from these disturbances in circadian rhythm (night wandering, insomnia, "sundowning") may be helped by bright-light exposure to increase zeitgeber strength (Lovell et al., 1995; Mishima et al., 1994; Okawa et al., 1991; Satlin et al., 1992; van Someren et al., 1997). Light treatment may also be helpful for the sleep-maintenance insomnia that occurs in the elderly (reviewed in Campbell, 1998).

Recommendations: Light Therapy for Other Disorders

(1) Studies of light therapy for pediatric seasonal affective disorder, subsyndromal seasonal affective disorder, nonseasonal depression, bulimia nervosa, panic disorder, and premenstrual dysphoric disorder show encouraging results, but further studies are required before light therapy can be recommended as a first-or second-line treatment. [Level 2 evidence]

(2) Light therapy may also be useful in combination with other treatments in these conditions. [Level 5 evidence]

(3) Light therapy may be useful in some disorders of the circadian system, including jet lag, shift work, circadian sleep disorders, and behavioural sleep-wake disturbances in dementia. [Level 2 and Level 4 evidence]

What novel treatments have been studied in SAD?

One well-conducted study has shown that high-density negative ions are superior to low-density negative ions in SAD, with response rates similar to those of light boxes (Terman et al., 1998). Another small-

sample study found that a one-hour outdoor walk in the morning was more effective than a placebo dim-light-box condition (Wirz-Justice et al., 1996). Total sleep deprivation was also effective in improving symptoms in 6 of 11 women with SAD, although the therapeutic effects of sleep deprivation are usually temporary (Graw et al., 1998).

Recommendations: Novel Treatments for SAD

(1) High-density negative ions and sleep deprivation protocols are promising treatments but require further study before being recommended as a treatment option. [Level 2 evidence]

(2) Regular morning outdoor walks, although not of proven efficacy, are low cost, convenient, readily available, and have no side effects. They may be suggested as adjuncts to regular treatment or as initial treatment for people with mild or subsyndromal symptoms. [Level 3 evidence]

What is an appropriate placebo condition for light-treatment studies?

Conclusions from clinical trials of light therapy studies have been generally limited by three factors: small sample size, short duration of treatment, and difficulty in establishing a "true" placebo-control condition. The placebo response encompasses all of the nonspecific factors in treatment, as opposed to any specific effects of an intervention. The placebo response is generally regarded as comprising three major factors: spontaneous improvement (including regression toward the mean), nonspecific treatment effects (including relief in obtaining treatment, contact with professionals who are interested and caring, educational information about the disease, etc.), and expectation effects. Various control conditions, ranging from "no treatment" to "sugar pills," have been devised to deal with these "placebo" factors, and all have limitations. The placebo response is generally high; meta-analyses of double-blind antidepressant studies have shown that at least one-third of patients respond to a placebo drug, and many individual antidepressant studies report placebo response rates of 40% to 50%. Of interest in this context is that a seasonality in placebo response has been documented in controlled drug trials of depression, with placebo response rates averaging 11% in winter and 33% in summer (Terman et al., 1989c).

A treatment such as bright-light exposure is particularly difficult to "blind." Many studies have used relatively dim light (e.g., 500 lux or less) as a control treatment, in part because 500 lux is presumed to be biologically inactive (i.e., it does not reliably suppress melatonin) while still being bright enough to be a plausible treatment for patients. In fact, dim light may be biologically active in some patients, since light as low as 100 lux has been shown to suppress melatonin under certain conditions. Other studies have used different novel conditions, such as negative-ion generators, to control for nonspecific therapeutic effects. In some of these studies, the negative-ion generator did not emit any ions, whereas in others low-density negative ions were used. Although these conditions can control for the nonspecific effects, they may still engender different expectations by patients and investigators.

In summary, there are a number of factors included in what is termed placebo and a number of different methodologies to control for these placebo effects. Any putative placebo condition has strengths and limitations. Because the limitations are different for different methodologies, one must be cautious when comparing "placebo response" between studies. This is especially true for treatments such as light therapy or psychotherapy, in which the treatments cannot be fully disguised. Finally, researchers try to minimize placebo effects because they are trying to determine specific treatment effects. However, clinicians try to maximize placebo effects because they want patients to get better.

Recommendation: Placebo Response

Clinicians should be aware of the "placebo response" and optimize those nonspecific factors that help patients to improve, including explaining treatments, regular follow-up, and an enthusiastic expectation of improvement. [Level 3 evidence]

References

Avery DH, Bolte MA, Cohen S, Millet MS. Gradual versus rapid dawn simulation treatment of winter depression. J Clin Psychiatry 1992b; 53:359-63.

Avery DH, Bolte MA, Dager SR, Wilson LG, Weyer M, Cox GB, Dunner DL. Dawn simulation treatment of winter depression: a controlled study. Am J Psychiatry 1993; 150:113-7.

Avery DH, Bolte MA, Wolfson JK, Kazaras AL. Dawn simulation compared with a dim red signal in the treatment of winter depression. Biol Psychiatry 1994; 36:180-8.

Avery D, Khan A, Dager S, Cohen S, Cox G, Dunner D. Is morning light exposure superior to evening light in treating seasonal affective disorder? Psychopharmacol Bull 1990a; 26:521-4.

Avery DH, Khan A, Dager SR, Cohen S, Cox GB, Dunner DL. Morning or evening bright light treatment of winter depression? The significance of hypersomnia. Biol Psychiatry 1991; 29:117-26.

Avery DH, Khan A, Dager SR, Cox GB, Dunner DL. Bright light treatment of winter depression: morning versus evening light. Acta Psychiatr Scand 1990b; 82:335-8.

Bauer MS, Kurtz JW, Rubin LB, Marcus JG. Mood and behavioral effects of four-week light treatment in winter depressives and controls. J Psychiatr Res 1994; 28:135-45.

Bielski RJ, Mayor J, Rice J. Phototherapy with broad spectrum white fluorescent light: a comparative study. Psychiatry Res 1992; 43:167-75.

Blehar MC, Lewy AJ. Seasonal mood disorders: consensus and controversy. Psychopharmacol Bull 1990; 26:465-94.

Boulos Z. Light treatment for jet lag and shift work. In Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998. 253-88.

Brainard GC. The healing light: interface of physics and biology. In Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998. 1-44.

Brainard GC, Sherry D, Skwerer RG, Waxler M, Kelly K, Rosenthal NE. Effects of different wavelengths in seasonal affective disorder. J Affect Disord 1990; 20:209-16.

Campbell SC. Bright light maintenance treatment of sleep maintenance insomnia and behavioural disturbance. In Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998. 289-304.

Campbell SC, Murphy PJ. Extraocular circadian phototransduction in humans. Science 1998; 279:396-9.

Carskadon MA, Acebo C. Parental reports of seasonal mood and behavior changes in children. J Am Acad Child Adolesc Psychiatry 1993; 32:264-9.

Chalmers I. The Cochrane Collaboration: preparing, maintaining and disseminating systematic reviews of the effects of health care. In Warren KS, Mosteller F (eds). Doing More Good than Harm: The Evaluation of Health Care Interventions. Ann NY Acad Sci 1993; 703:156-63.

Chan PK, Lam RW, Perry KF. Mania precipitated by light therapy for patients with SAD. J Clin Psychiatry 1994; 55:454.

Cooke LB, Thompson C. Seasonal affective disorder and response to light in two patients with learning disability. J Affect Disord 1998; 48:145-8.

Doghramji K, Gaddy JR, Stewart KT, Rosenthal NE, Brainard GC. 2- versus 4-hour evening phototherapy of seasonal affective disorder. J Nerv Ment Dis 1990; 178:257-60.

Eastman CI, Lahmeyer HW, Watell LG, Good GD, Young MA. A placebo-controlled trial of light treatment for winter depression. J Affect Disord 1992; 26:211-21.

Eastman CI, Young MA, Fogg LF, Liu L, Meaden PM. Bright light treatment of winter depression: a placebo-controlled trial. Arch Gen Psychiatry 1998; 55:883-9.

Gallenga PE, Lobefalo L, Mastropasqua L, Liberatoscioli A. Photic maculopathy in a patient receiving bright light therapy. Am J Psychiatry 1997; 154:1319.

Gallin PF, Terman M, Reme CE, Rafferty B, Terman JS, Burde RM. Ophthalmologic examination of patients with seasonal affective disorder, before and after bright light therapy. Am J Ophthalmol 1995; 119:202-10.

Giedd JN, Swedo SE, Lowe CH, Rosenthal NE. Case series: pediatric seasonal affective disorder: a follow-up report. J Am Acad Child Adolesc Psychiatry 1998; 37:218-20.

Glod CA, Teicher MH, Polcari A, McGreenery CE, Ito Y. Circadian rest-activity disturbances in children with seasonal affective disorder. J Am Acad Child Adolesc Psychiatry 1997; 36:188-95.

Gorman CP, Wyse PH, Demjen S, et al. Ophthalmological profile of 71 SAD patients: a significant correlation between myopia and SAD. Society for Light Treatment and Biological Rhythms Abstracts 1993; 5:8.

Graw P, Haug HJ, Leonhardt G, Wirz-Justice A. Sleep deprivation response in seasonal affective disorder during a 40-h constant routine. J Affect Disord 1998; 48:69-74.

Grota LJ, Yerevanian BI, Gupta K, Kruse J, Zborowski L. Phototherapy for seasonal major depressive disorder: effectiveness of bright light of high or low intensity. Psychiatry Res 1989; 29:29-35.

Hellekson CJ, Kline JA, Rosenthal NE. Phototherapy for seasonal affective disorder in Alaska. Am J Psychiatry 1986; 143:1035-7.

Isaacs G, Stainer DS, Sensky TE, Moor S, Thompson C. Phototherapy and its mechanisms of action in seasonal affective disorder. J Affect Disord 1988; 14:13-9.

James SP, Wehr TA, Sack DA, et al. Treatment of seasonal affective disorder with light in the evening. Br J Psychiatry 1985; 147:424-8.

Joffe RT, Moul DE, Lam RW, Levitt AJ, Teicher MH, Lebegue B, Oren DA, Buchanan A, Glod CA, Murray MG, et al. Light visor treatment for seasonal affective disorder: a multicenter study. Psychiatry Res 1993; 46:29-39.

Kasper S, Rogers SL, Madden PA, Joseph-Vanderpool JR, Rosenthal NE. The effects of phototherapy in the general population. J Affect Disord 1990b; 18:211-9.

Kasper S, Rogers SL, Yancey AL, Schulz PM, Skwerer RG, Rosenthal NE. Phototherapy in subsyndromal seasonal affective disorder (S-SAD) and "diagnosed" controls. Pharmacopsychiatry 1988; 21:428-9.

Kasper S, Rogers SL, Yancey A, Schulz PM, Skwerer RG, Rosenthal NE. Phototherapy in individuals with and without subsyndromal seasonal affective disorder. Arch Gen Psychiatry 1989a; 46:837-44.

Kasper S, Wehr TA, Bartko JJ, Gaist PA, Rosenthal NE. Epidemiological findings of seasonal changes in mood and behavior: a telephone survey of Montgomery County, Maryland. Arch Gen Psychiatry 1989b; 46:823-33.

Krauchi K, Wirz-Justice A, Graw P. High intake of sweets late in the day predicts a rapid and persistent response to light therapy in winter depression. Psychiatry Res 1993; 46:107-17.

Kripke DF. Photoperiodic mechanisms for depression and its treatment. In Perris C, Struwe G, Jansson B (eds). Biological Psychiatry. Elsevier-North: Holland Biomedical Press, 1981. 1249-52.

Kripke DF. Light treatment for nonseasonal depression: speed, efficacy, and combined treatment. J Affect Disord 1998; 49:109-17.

Kripke DF, Mullaney DJ, Klauber MR, Risch SC, Gillin JC. Controlled trial of bright light for nonseasonal major depressive disorders. Biol Psychiatry 1992; 31:119-34.

Labbate LA, Lafer B, Thibault A, Rosenbaum JF, Sachs GS. Influence of phototherapy treatment duration for seasonal affective disorder: outcome at one vs. two weeks. Biol Psychiatry 1995; 38:747-50.

Lafer B, Sachs GS, Labbate LA, Thibault A, Rosenbaum JF. Phototherapy for seasonal affective disorder: a blind comparison of three different schedules. Am J Psychiatry 1994; 151:1081-3.

Lam RW. Morning light therapy for winter depression: predictors of response. Acta Psychiatr Scand 1994a; 89:97-101.

Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998a.

Lam RW, Buchanan A, Clark CM, Remick RA. Ultraviolet versus non-ultraviolet light therapy for seasonal affective disorder. J Clin Psychiatry 1991b; 52:213-6.

Lam RW, Buchanan A, Mador JA, Corral MR, Remick RA. The effects of ultraviolet-A wavelengths in light therapy for seasonal depression. J Affect Disord 1992b; 24:237-43.

Lam RW, Goldner EM. Seasonality of bulimia nervosa and treatment with light therapy. In Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998. 193-220.

Lam RW, Goldner EM, Solyom L, Remick RA. A controlled study of light therapy for bulimia nervosa. Am J Psychiatry 1994; 151:744-50.

Lam RW, Kripke DF, Gillin JC. Phototherapy for depressive disorders: a review. Can J Psychiatry 1989b; 34:140-7.

Lam RW, Terman M, Wirz-Justice A. Light therapy for depressive disorders: indications and efficacy. Modern Problems of Pharmacopsychiatry 1997b; 25:215-34.

Lee TMC. Phototherapy for Seasonal Affective Disorder: A Meta-Analytic Review. Unpublished PhD diss. University of Alberta, Edmonton, 1995.

Lee TM, Blashko CA, Janzen HL, Paterson JG, Chan CC. Pathophysiological mechanism of seasonal affective disorder. J Affect Disord 1997a; 46:25-38.

Lee TM, Chan CC, Paterson JG, Janzen HL, Blashko CA. Spectral properties of phototherapy for seasonal affective disorder: a meta-analysis. Acta Psychiatr Scand 1997b; 96:117-21.

Levitt AJ, Brown GM, Kennedy SH, Stern K. Tryptophan treatment and melatonin response in a patient with seasonal affective disorder. J Clin Psychopharmacol 1991; 11:74-5.

Levitt AJ, Joffe RT, King E. Dim versus bright red (light-emitting diode) light in the treatment of seasonal affective disorder. Acta Psychiatr Scand 1994; 89:341-5.

Levitt AJ, Joffe RT, Moul DE, Lam RW, Teicher MH, Lebegue B, Murray MG, Oren DA, Schwartz P, Buchanan A, et al. Side effects of light therapy in seasonal affective disorder. Am J Psychiatry 1993b; 150:650-2.

Levitt AJ, Wesson VA, Joffe RT, Maunder RG, King EF. A controlled comparison of light box and head-mounted units in the treatment of seasonal depression. J Clin Psychiatry 1996; 57:105-10.

Lewy AJ, Bauer VK, Cutler NL, Sack RL, Ahmed S, Thomas KH, Blood ML, Latham Jackson JM. Morning vs evening light treatment of patients with winter depression. Arch Gen Psychiatry 1998b; 55:890-6.

Lewy AJ, Kern HA, Rosenthal NE, Wehr TA. Bright artificial light treatment of a manic-depressive patient with a seasonal mood cycle. Am J Psychiatry 1982; 139:1496-8.

Lewy AJ, Sack RL, Miller LS, Hoban TM. Antidepressant and circadian phase-shifting effects of light. Science 1987a; 235:352-4.

Lewy AJ, Wehr TA, Goodwin FK, Newsome DA, Markey SP. Light suppresses melatonin secretion in humans. Science 1980; 210:1267-9.

Lingjaerde O, Foreland AR, Dankertsen J. Dawn simulation vs. lightbox treatment in winter depression: a comparative study. Acta Psychiatr Scand 1998; 98:73-80.

Lovell BB, Ancoli-Israel S, Gevirtz R. Effect of bright light treatment on agitated behavior in institutionalized elderly subjects. Psychiatry Res 1995; 57:7-12.

Mackert A, Volz HP, Stieglitz RD, Muller-Oerlinghausen B. Phototherapy in nonseasonal depression. Biol Psychiatry 1991; 30:257-68.

Magnusson A, Kristbjarnarson H. Treatment of seasonal affective disorder with high-intensity light: a phototherapy study with an Icelandic group of patients. J Affect Disord 1991; 21:141-7.

Meesters Y. [Light therapy in three children with winter depression]. [Dutch]. Nederlands Tijdschrift Voor Geneeskunde 1995; 139:2664-6.

Meesters Y, Jansen JH, Beersma DG, Bouhuys AL, Van den Hoofdakker RH. Light therapy for seasonal affective disorder: the effects of timing. Br J Psychiatry 1995; 166:607-12.

Mishima K, Okawa M, Hishikawa Y. Circadian rhythm of melatonin secretion and body temperature in a patient with seasonal affective disorder. Jpn J Psychiatry Neurol 1991; 45:161.

Nagayama H, Sasaki M, Ichii S, Hanada K, Okawa M, Ohta T, Asano Y, Sugita Y, Yamazaki J, Kohsaka M, et al. Atypical depressive symptoms possibly predict responsiveness to phototherapy in seasonal affective disorder. J Affect Disord 1991; 23:185-9.

Neumeister A, Goessler R, Lucht M, Kapitany T, Bamas C, Kasper S. Bright light stabilizes the antidepressant effect of sleep deprivation. Biol Psychiatry 1996; 39:16-21.

Norden MJ, Avery DH. A controlled study of dawn simulation in subsyndromal winter depression. Acta Psychiatr Scand 1993; 88:67-71.

Okawa M, Shirakawa S, Uchiyama M, Oguri M, Kohsaka M, Mishima K, Sakamoto K, Inoue H, Kamei K, Takahashi K. Seasonal variation of mood and behaviour

in a healthy middle-aged population in Japan. Acta Psychiatr Scand 1996; 94:211-6.

Oren DA, Brainard GC, Johnston SH, Joseph-Vanderpool JR, Sorek E, Rosenthal NE. Treatment of seasonal affective disorder with green light and red light. Am J Psychiatry 1991a; 148:509-11.

Oren DA, Rosenthal NE. Seasonal affective disorders. In Paykel ES (ed). Handbook of Affective Disorders. London: Churchill Livingstone, 1992. 551-67.

Oren DA, Rosenthal FS, Rosenthal NE, Waxler M, Wehr TA. Exposure to ultraviolet B radiation during phototherapy. Am J Psychiatry 1990; 147:675-6.

Reichborn-Kjennerud T, Lingjaerde O, Oreland L. Platelet monoamine oxidase activity in patients with winter seasonal affective disorder. Psychiatry Res 1996; 62:273-80.

Reme CE, Rol P, Grothmann K, Kaase H, Terman M. Bright light therapy in focus: lamp emission spectra and ocular safety. Technology and Health Care 1996; 4:403-13.

Rosenthal NE, Carpenter CJ, James SP, Parry BL, Rogers SL, Wehr TA. Seasonal affective disorder in children and adolescents. Am J Psychiatry 1986a; 143:356-8.

Rosenthal NE, Joseph-Vanderpool JR, Levendosky AA, Johnston SH, Allen R, Kelly KA, et al. Phase-shifting effects of bright morning light as treatment for delayed sleep phase syndrome. Sleep 1990; 13:354-61.

Rosenthal NE, Levendosky AA, Skwerer RG, Joseph-Vanderpool JR, Kelly KA, Hardin T, Kasper S, DellaBella P, Wehr TA. Effects of light treatment on core body temperature in seasonal affective disorder. Biol Psychiatry 1990; 27:39-50.

Rosenthal NE, Moul DE, Hellekson CJ, Oren DA, Frank A, Brainard GC, Murray MG, Wehr TA. A multicenter study of the light visor for seasonal affective disorder: no difference in efficacy found between two different intensities. Neuropsychopharmacology 1993; 8:151-60.

Rosenthal NE, Rotter A, Jacobsen FM, Skwerer RG. No mood-altering effects found after treatment of normal subjects with bright light in the morning. Psychiatry Res 1987b; 22:1-9.

Rosenthal NE, Sack DA, Carpenter CJ, Parry BL, Mendelson WB, Wehr TA. Antidepressant effects of light in seasonal affective disorder. Am J Psychiatry 1985; 142:163-70.

Rosenthal NE, Sack DA, Gillin JC, Lewy AJ, Goodwin FK, Davenport Y, Mueller PS, Newsome DA, Wehr TA. Seasonal affective disorder: a description of the syndrome and preliminary findings with light therapy. Arch Gen Psychiatry 1984a; 41:72-80.

Rosenthal NE, Sack DA, Skwerer RG, Jacobsen FM, Wehr TA. Phototherapy for seasonal affective disorder. J Biol Rhythms 1988b; 3:101-20.

Ruhrmann S, Kasper S, Hawellek B, Martinez B, Hoeflich G, Nickelsen T, Moeller H-J. Effects of fluoxetine versus bright light in the treatment of seasonal affective disorder. Psychol Med 1998; 28:923-33.

Sack RL, Lewy AJ, White DM, Singer CM, Fireman MJ, Vandiver R. Morning vs evening light treatment for winter depression: evidence that the therapeutic effects of light are mediated by circadian phase shifts [published erratum ap-

pears in Arch Gen Psychiatry 1992; 49:650]. Arch Gen Psychiatry 1990; 47: 343-51.

Satlin A, Volicer L, Ross V, Herz L, Campbell S. Bright light treatment of behavioral and sleep disturbances in patients with Alzheimer's disease. Am J Psychiatry 1992; 149:1028-32.

Schwartz PJ, Brown C, Wehr TA, Rosenthal NE. Winter seasonal affective disorder: a follow-up study of the first 59 patients of the National Institute of Mental Health Seasonal Studies Program. Am J Psychiatry 1996; 153:1028-36.

Sonis WA, Yellin AM, Garfinkel BD, Hoberman HH. The antidepressant effect of light in seasonal affective disorder of childhood and adolescence. Psychopharmacol Bull 1987; 23:360-3.

Stewart KT, Gaddy JR, Byrne B, Miller S, Brainard GC. Effects of green or white light for treatment of seasonal depression. Psychiatry Res 1991; 38:261-70.

Swaab DF, Fliers E, Partiman TS. The SCN of the human brain in relation to sex, age, and senile dementia. Brain Res 1985; 342:37-44.

Swedo SE, Allen AJ, Glod CA, Clark CH, Teicher MH, Richter D, Hoffman C, Hamburger SD, Dow S, Brown C, et al. A controlled trial of light therapy for the treatment of pediatric seasonal affective disorder. J Am Acad Child Adolesc Psychiatry 1997; 36:816-21.

Swedo SE, Pleeter JD, Richter DM, Hoffman CL, Allen AJ, Hamburger SD, Turner EH, Yamada EM, Rosenthal NE. Rates of seasonal affective disorder in children and adolescents. Am J Psychiatry 1995; 152:1016-9.

Tam EM, Lam RW, Levitt AJ. Treatment of seasonal affective disorder: a review. Can J Psychiatry 1995; 40:457-66.

Teicher MH, Glod CA, Oren DA, Schwartz PJ, Luetke C, Brown C, Rosenthal NE. The phototherapy light visor: more to it than meets the eye. Am J Psychiatry 1995; 152:1197-202.

Terman M, Amira L, Terman JS, Ross DC. Predictors of response and nonresponse to light treatment for winter depression. Am J Psychiatry 1996; 153:1423-9.

Terman M, Botticelli SR, Link B, Link MJ, Hardin T, Rosenthal NE. Seasonal symptom patterns in New York: patients and population. In Silverstone T, Thompson C (eds). Seasonal Affective Disorder. London: Clinical Neuroscience, 1989c. 77-95.

Terman M, Boulos Z, Campbell SS, Dijk D-J, Eastman CI, Lewy AJ. Light treatment for sleep disorders: ASDA/SLTBR Joint Task Force Report. J Biol Rhythms 1995b; 10:101-76.

Terman M, Reme CE, Rafferty B, Gallin PF, Terman JS. Bright light therapy for winter depression: potential ocular effects and theoretical implications. Photochem Photobiol 1990b; 51:781-92.

Terman M, Schlager D, Fairhurst S, Perlman B. Dawn and dusk simulation as a therapeutic intervention. Biol Psychiatry 1989a; 25:966-70.

Terman M, Terman JS, Quitkin FM, McGrath PJ, Stewart JW, Rafferty B. Light therapy for seasonal affective disorder: a review of efficacy. Neuropsychopharmacology 1989b; 2:1-22.

Terman M, Terman JS, Rafferty B. Experimental design and measures of success in the treatment of winter depression by bright light. Psychopharmacol Bull 1990c; 26:505-10.

Terman M, Terman JS, Ross DC. A controlled trial of timed bright light and negative air ionization for treatment of winter depression. Arch Gen Psychiatry 1998; 55:875-82.

Terman JS, Terman M, Schlager D, Rafferty B, Rosofsky M, Link MJ, Gallin PF, Quitkin FM. Efficacy of brief, intense light exposure for treatment of winter depression. Psychopharmacol Bull 1990a; 26:3-11.

Thalen BE, Kjellman BF, Morkrid L, Wibom R, Wetterberg L. Light treatment in seasonal and nonseasonal depression. Acta Psychiatr Scand 1995b; 91:352-60.

Thompson C, Rodin I, Birtwhistle J. Light therapy for seasonal and nonseasonal affective disorder: a Cochrane meta-analysis. Society for Light Treatment and Biological Rhythms Abstracts 1999; 11:11.

van Someren EJW, Kessler A, Mirmiran M, Swaab DF. Indirect bright light improves circadian rest-activity rhythm disturbances in demented patients. Biol Psychiatry 1997; 41:955-63.

Vanselow W, Dennerstein L, Armstrong S, Lockie P. Retinopathy and bright light therapy. Am J Psychiatry 1991; 148:1266-7.

Wehr TA, Skwerer RG, Jacobsen FM, Sack DA, Rosenthal NE. Eye versus skin phototherapy of seasonal affective disorder. Am J Psychiatry 1987b; 144:753-7.

Wesson VA, Levitt AJ. Light therapy for seasonal affective disorder. In Lam RW (ed). Seasonal Affective Disorder and Beyond: Light Treatment for SAD and Non-SAD Conditions. Washington, DC: American Psychiatric Press, 1998. 45-90.

Winton F, Corn T, Huson LW, Franey C, Arendt J, Checkley SA. Effects of light treatment upon mood and melatonin in patients with seasonal affective disorder. Psychol Med 1989; 19:585-90.

Wirz-Justice A, Bucheli C, Graw P, Kielholz P, Fisch HU, Woggon B. How much light is antidepressant? Psychiatry Res 1986; 17:75-6.

Wirz-Justice A, Bucheli C, Schmid AC, Graw P. A dose relationship in bright white light treatment of seasonal depression. Am J Psychiatry 1986b; 143:932-3.

Wirz-Justice A, Graw P, Krauchi K, Gisin B, Jochum A, Arendt J, Fisch HU, Buddeberg C, Poldinger W. Light therapy in seasonal affective disorder is independent of time of day or circadian phase. Arch Gen Psychiatry 1993; 50:929-37.

Wirz-Justice A, Graw P, Krauchi K, Sarrafzadeh A, English J, Arendt J, Sand L. "Natural" light treatment of seasonal affective disorder. J Affect Disord 1996; 37:109-20.

Wirz-Justice A, Graw P, Roosli H, Glauser G, Fleischhauer J. An open trial of light therapy in hospitalized major depression. J Affect Disord 1999; 52:291-2.

Yamada N, Martin-Iverson MT, Daimon K, Tsujimoto T, Takahashi S. Clinical and chronobiological effects of light therapy on nonseasonal affective disorders. Biol Psychiatry 1995; 37:866-73.

Yerevanian BI, Anderson JL, Grota LJ, Bray M. Effects of bright incandescent light on seasonal and nonseasonal major depressive disorder. Psychiatry Res 1986; 18:355-64.