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Depressed Patients Hospitalized in Southeast-Facing Rooms Are Discharged Earlier than Patients in Northwest-Facing Rooms

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Keywords

Depression · Light · Vitamin D · Architecture · Daylight · Psychiatry · Inpatient wards

Abstract

Background and Aim: Improvement in patients admitted to inpatient wards with severe depression is slow, and such patients are often discharged with residual symptoms which put them at risk for relapse. New treatments that can speed up recovery are highly desired. This naturalistic follow-up study in a specialized affective disorders unit investigated the impact of daylight on the length of hospital stay and improvement of depression. ***Methods:*** For a period of 1 year, we collected data on sociodemographics, length of stay, vitamin D, and depression severity for patients in an inpatient affective disorders unit. The ward is located with one facade that faces southeast (SE); the opposite one faces northwest (NW) and receives far less light and no direct sunlight during winter. ***Results:*** SE-facing rooms received far more daylight than NW-facing rooms. The length of stay was significantly lower in the SE rooms, i.e., 29.2 (±26.8) versus 58.8 (±42.0) days in the NW rooms ($p = 0.01$). There was a statistically nonsignificant greater reduction of 52.2% in depression severity for the patients staying in the SE rooms compared to 42.2% in the NW rooms, which may nevertheless be clinically relevant. ***Conclusion:*** Due to the study design, no causality for the observed difference in length of stay can be given, but the results support findings in previous studies of the importance of architectural orientation providing natural daylight as a factor for improvement.
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Introduction

Improvement in patients with severe depression admitted to inpatient wards is slow, in spite of the intensive use of acknowledged treatment options like psychoeducation, psychotherapy, and psychopharmacology. Residual symptoms at discharge are very common due to the short hospitalization caused by a restricted number of beds. It is therefore imperative to explore conditions that could accelerate improvement.

Light therapy has repeatedly been shown to have an antidepressant effect in seasonal affective disorder (SAD), and also in nonseasonal depression, both as a monotherapy or when used as an adjunct to antidepressants [1–5].

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The human physiology is very sensitive to both the intensity and the spectral wavelength composition of light, and even the LED backlight from laptops, which has a high amount of blue light, reduces sleepiness and notably influences circadian physiology when used in the evening [6].

Light has a profound impact on the brain and exerts its effect mainly through the eyes, for vision via the retinal rods and cones on the one hand, but also through the nonvisual, intrinsically photosensitive retinal ganglion cells that have central connections to several brain circuits [7]. Evidence from humans and animals now suggests that light can influence cognitive and mood functions directly through the intrinsically photosensitive retinal ganglion cells and their central brain connections [8].

One of the main hypotheses of the antidepressant effect of light has focused on the impact of light on the circadian system [9]. According to the phase response curve to light, light in the first part of the day advances circadian rhythms and light in the evening delays them [10]. This effect is mediated through the suprachiasmatic nuclei in the hypothalamus and the pineal gland where light suppresses melatonin production [11]. Phase advance of the sleep-wake cycle has been found to have an antidepressant effect in patients with major depression [12, 13] and, conversely, sleep delays have been found to be depressogenic [14].

Light is the most important zeitgeber and, as such, the strongest signal to maintain a stable sleep-wake cycle and to prevent sleep from drifting to later [15]. Patients with depression are prone to sleep delays. Robillard et al. [16] found that young patients with bipolar and unipolar depression were sleep-delayed compared to normal values in the population. Furthermore, we were able to confirm that depressed patients tend to drift to a later sleep schedule when discharged from inpatient wards [14]. Thus, timed lighting with appropriate intensity and spectral distribution should be able to entrain and advance a drifted sleep-wake cycle in patients with depression and thereby improve their condition.

Since the discovery of the antidepressant effect of light [17] in 1984, the administration of light therapy has primarily been supplied by light boxes. In clinical use, light therapy delivered from a light box has few and mild side effects, but agitation is known to occur and, very rarely hypomania evolves [18]. Light therapy is, however, time-consuming, with a recommended daily treatment time of 30–60 min throughout the whole season. Recently, a few studies have investigated the effect of general ambient lighting with temporal regulation of the spectral composition and intensity of light sources, in dementia [19], somatic disorders [20], and in healthy individuals [21]. However, there is a lack of inpatient studies investigating this area in patients with depressive disorders.

A few studies have shown ambient light levels to be related to the length of inpatient stays in psychiatric wards. Benedetti et al. [22] compared length of inpatient stay in relation to season and ambient light on the wards. They found that bipolar, but not unipolar patients staying in a room orientated towards the east in the summer season had significantly shorter inpatient stays. Beauchemin and Hays [23] showed that, in a mixed group of bipolar and unipolar depressed patients, the inpatient stay in the brighter rooms was significantly shorter, amounting to 16.9 days versus 19.5 days in the dimly lit rooms ($p < 0.05$). Thus, it is a likely hypothesis that lighting conditions in affective inpatient wards can influence improvement from depression.

This study aimed to assess the impact of daylight in rooms on patients admitted to an inpatient ward. Primary outcomes were the length of stay and the level of depression. It was planned as a preliminary study to a currently ongoing randomized controlled study with a newly developed lighting system mimicking sunlight. Our hypothesis was that the length of stay would be shorter for patients allocated to SE-facing rooms than for those in NW-facing rooms. We also hypothesized that the speed of a reduction in levels of depression would be higher in the SE-facing rooms as the decision for discharge is mainly based on the level of depression.

Methods

Study Design

The study was designed as a naturalistic follow-up study with between-subject comparisons. It was approved by the Psychiatric Center Copenhagen and the Danish Data Agency (RHP-2012-58-0004); it did not subject participants to any additional tasks or procedures, and did not include any additional contact with the patients, so it did not need approval from the local ethics committee according to Danish law. All general procedures followed the Declaration of Helsinki for Research in Humans. All data were pseudo-anonymized.

The treatment and general procedures in the ward were not changed during the study, and all data were collected from case report files and administrative notes from the ward regarding room allocation. Thus, the nursing staff filled in the room allocation for all patients on a daily basis including when patients changed rooms during their stay.

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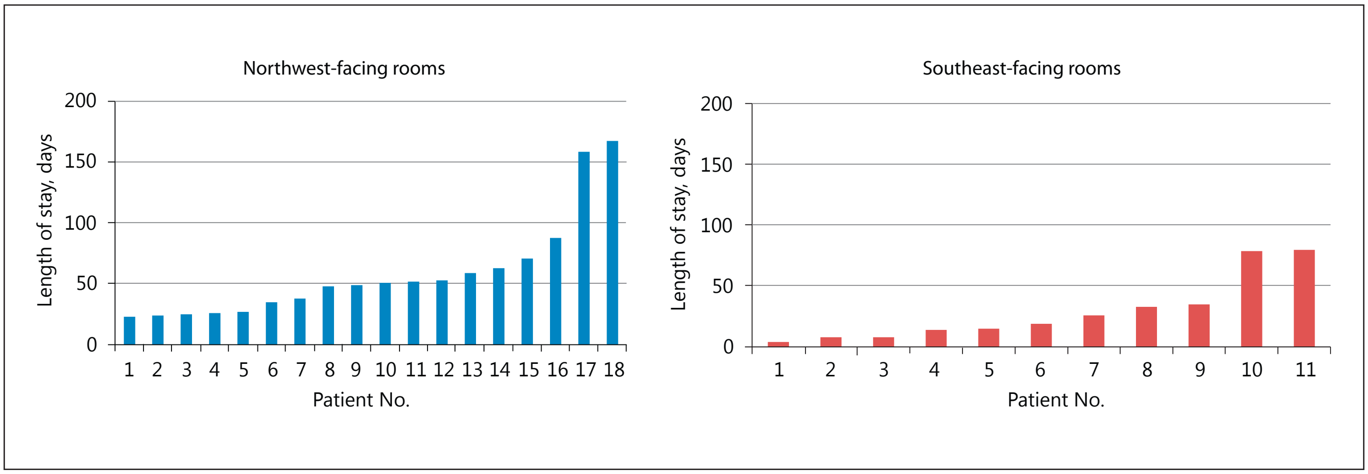

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Fig. 1. Distribution of length of stay for individual patients in the northwest- and southeast-facing rooms.

Participants

All patients admitted to an affective disorders unit at the Psychiatric Center Copenhagen were registered. The inclusion criteria were patients with a depressive phase as part of a unipolar or bipolar disorder who occupied a room at the same geographical side of the building during their whole stay on the ward.

Data Collection and Light Measurements

The ward for patients with affective disorders is housed in a building with bedrooms facing either SE or NW (Fig. 1, 2). The building has 2 double and 5 single rooms on the NW side and 2 doubles and a single room on the SE side, i.e., a total of 14 beds.

Prior to the start of the study, illuminance and spectral composition were measured in rooms similar to the bedrooms, located one floor above. Measurements for light intensity were done with a Hagner EC1 Luxmeter 0.8 m above the floor and at a 0.3-m distance from the window pane, on a day with a clear sky at 12:00. The intensity measurements thus reflect the maximum light intensity through the window for the respective dates. For the long-term light intensity measurements, we used automated simultaneous time-lapse photography [24] with a fixed shutter speed and aperture (Fig. 3), with 1 photograph taken every 15 min on 2 consecutive days. Spectral composition was measured with a spectrometer (UPRTek MK350) every second hour for 2 days. These measurements were performed prior to the start of the study near the summer solstice (7 July 2014), and were then repeated at around the time of the autumn equinox (19 September 2014), and winter solstice (4 January 2015).

Assessments

Depression severity was measured using the Hamilton Depression Rating Scale 17-item version (HAM-D_{17}) [25] upon admission to the ward and at discharge, according to national guidelines [26], and recorded in a paper-and-pen version in the patients' case-files. A rating window of ±4 days was allowed in relation to admission and discharge. The ratings were done by the attending physicians on the ward.

The nursing staff at the unit consecutively registered room occupancy for each patient, adding a note whenever a patient was discharged or reallocated to another room. Vitamin D level was measured when patients were admitted and the data collected from the hospital's electronic laboratory system. All sociodemographic data and diagnostic codes were obtained from the case files. The length of stay was calculated at the end of the study period from the patient administrative systems based on individual patients' case records. Medication use was not registered.

Outcomes

The primary outcome was the difference in length of stay between the SE- and NW-facing rooms. The secondary outcome was the difference in reduction in depression severity measured by the HAM-D_{17} scale. The tertiary outcome was any interaction between vitamin D level, depression severity, season of admission, and length of stay.

Sample Size

Patients were allocated to the SE or NW wing according to the availability of rooms. In general, there were no unoccupied rooms on the ward, and any new patient was thus allocated to a room vacated on the same day by a discharged patient. The number of patients on the ward who fulfilled the diagnostic criteria for an actual depression or depressive phase was estimated to be 50% of the total number of patients, and we estimated that only 50% of the patients would continue to stay in a room on the same side of the building. Thus, with an expected admission to the unit of 10 new patients/month, only 2.5 of would fulfil the inclusion criteria. The sample size calculation was based on an expected mean stay of 45 days. The expected difference in stay between patients occupying a SE- or NW-facing room was hypothesized to be 10 days. With an expected standard deviation (SD) of length of stay of 10 days, a type II error of 0.05, and a power of 0.80, we needed 17 patients in each group, i.e., a total of 34 patients. With 2.5 new patients in this category per month, we needed a sampling time of 34/2.5 = 13.6 months. There was no randomization or blinding in this study.

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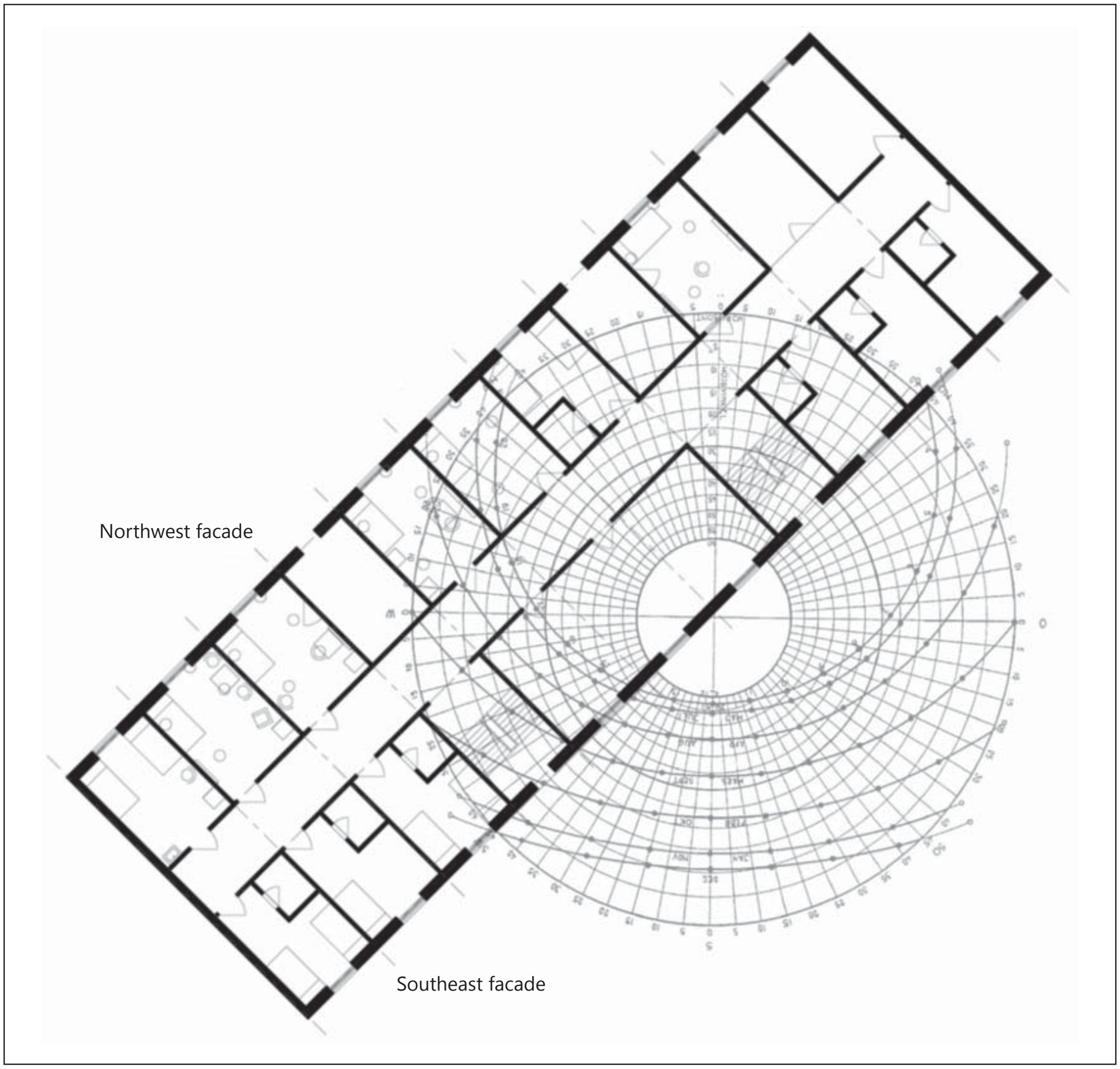

Fig. 2. Orientation of individual rooms.

Statistics

Data were collected continuously, entered into Excel sheets, and thereafter transferred to an SAS database stored on a secure server. Data analyses were done by K.M. in collaboration with the study group, using the SAS 9.4 and SAS Enterprise Guide 7.1 systems. The length of stay was analyzed with the nonparametric Kruskal-Wallis test, due to the lack of normal distribution of the data. Depression severity data were analyzed with the Student *t* test. The relation between length of stay, depression scores, seasons, and vitamin D levels was analyzed in a general linear model, with length of stay as the dependent variable and geographical location of the room (SE or NW), depression level, season, and vitamin D levels as independent variables. For depression scores, only patients with scores both at admission and discharge were used. The significance level was set at $p = 0.05$ (2-sided).

Results

The registration period was from June 2014 to June 2015. At the end of the registration period, a total of 67 patients had been admitted and discharged, allowing us to calculate their length of stay.

Daylight Measurements

At the summer solstice, at 12:00, the daylight near the window in the SE- and NW-facing rooms, respectively, was 60,000 and 3,000 lx; at the autumn equinox, it was 40,000 and 2,000 lx, respectively; and at the winter solstice, it was 20,000 and 1,200 lx, respectively. The electric

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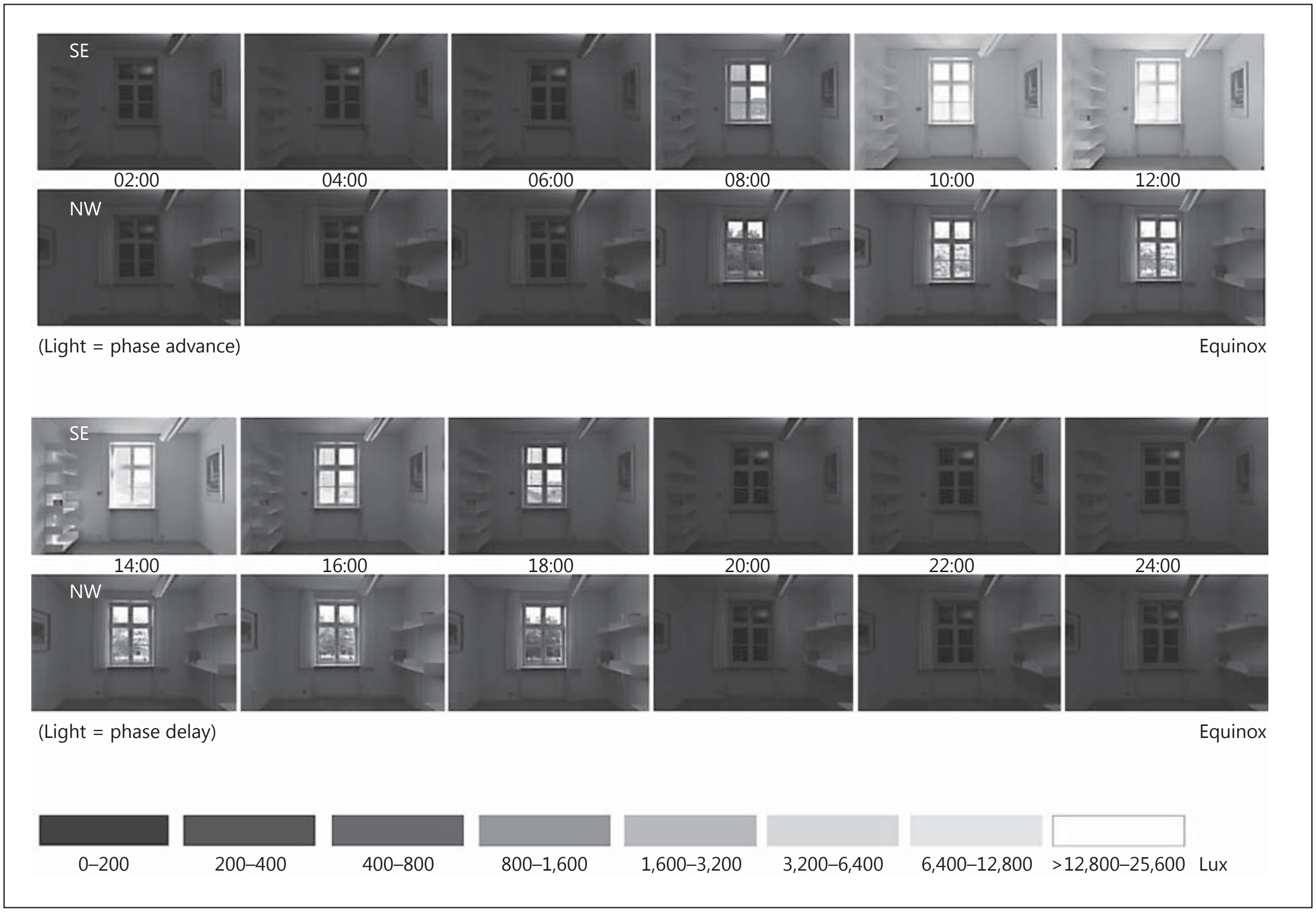

Fig. 3. Simultaneous time-lapse photography of a southeast (SE)-facing room and a northwest (NW)-facing room at autumn equinox. The differences in light are mainly characterized by a relatively higher intensity of early morning light in the SE-facing rooms until 14:00, and a relatively higher intensity of late evening light in the NW-facing rooms after 14:00.

light was identical in all rooms on the ward, being provided by compact fluorescent lamps (CFLs), so-called 3-power-CFL light sources.

Figure 3 shows the change in illuminance through a 24-h cycle in a SE- and a NW-facing room in the study building, as recorded by automated simultaneous time-lapse photography.

Patient Outcomes

Of the 67 patients, 37.3% (n = 25) had bipolar disorder with manic, hypomanic, depressed, mixed, or unspecified phases, 19.4% (n = 13) had a single depressive episode, 34.3% (n = 23) had recurrent depression, and 9.0% (n = 6) had nonaffective disorders (1 case of schizophrenic disorder, 1 of personality disorder, 3 of adjustment disorder, and 1 of hyperkinetic disorder). According to the inclusion criteria, we only considered patients who experienced a current depressive episode as part of either a unipolar or bipolar disorder. In all, 48 patients fulfilled this diagnostic criterion. Furthermore, we only considered patients that had either stayed in the same room during the inpatient stay or were allocated to another room at the same geographical side of the building (NW or SE). Patients moving across the hallway were thus excluded. In all, 29 patients fulfilled these criteria: 6 with bipolar depression, 10 with unipolar single-episode depression, and 13 with a recurrent unipolar depressive disorder. Eleven patients were located on the SE side and 18 on the NW side of the building.

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Table 1. Sociodemographics

	Total inpatient sample[1] (n = 67)	Included sample[2] (n = 29)	Included sample staying in NW rooms (n = 18)	Included sample staying in SE rooms (n = 11)
Age, years (SD) [range]	43.0 (15.2) [21–80]	44.7 (14.1) [24–72]	43.6 (13.4) [24–69]	46.4 (15.8) [27–72]
Female gender	61.2% (41/67)	55.2% (16/67)	50.0% (9/18)	63.6% (7/11)
Suicide attempt in current episode	10.6% (7/66)	10.3% (3/29)	5.9% (1/17)	18.2% (2/11)
Smoking	47.6% (30/63)	33.3% (9/27)	29.4% (5/17)	44.4% (4/9)
Bipolar, depressed phase	17.9% (12/67)	20.7% (6/29)	16.7% (3/18)	27.3% (3/11)
Unipolar single episode	19.4% (13/67)	34.5% (10/29)	33.3% (6/18)	36.4% (4/11)
Unipolar recurrent episode	34.3% (23/67)	44.8% (13/29)	50.0% (9/18)	36.4% (4/11)

[1] All patients admitted and discharged during the registration period.
[2] All patients with a unipolar depressed phase or a depressed phase as part of a bipolar disorder who stayed in the same room from admission to discharge.

Table 2. Outcomes

Parameter	Total inpatient sample[1] (n = 67)	Included sample[2] (n = 29)	Included sample staying in NW rooms (n = 18)	Included sample staying in SE rooms (n = 11)
Length of stay, days	46.0 (41.9) [3–172]	47.6 (39.3) [4–168]	58.8 (42.0) [23–168]	29.2[a] (26.8) [4–80]
Median length of stay (IQR), days	34.0 (57)	35 (35)	50.0 (36)	19.0[a] (27)
Available HAM-D_{17} scores at admission	22.9 (5.7) [7–36] n = 36	24.2 (5.4) [15–36] n = 21	24.0 (4.8) [16–34] n = 12	24.6 (6.4) [15–36] n = 9
Available HAM-D_{17} scores at discharge	13.2 (5.7) [3–28] n = 26	13.3 (5.6) [3–28] n = 16	13.5 (5.7) [8–28] n = 11	12.8 (6.1) [3–18] n = 5
HAM-D_{17} scores at admission of patients for whom both baseline and end point scores were available	23.7 (5.4) [13–36] n = 20	24.4 (5.3) [16–36] n = 14	23.0 (4.2) [16–30] n = 9	26.8 (6.6) [20–36] n = 5
HAM-D_{17} scores at discharge of patients for whom both baseline and end point scores were available	12.4 (5.6) [3–28] n = 20	13.1 (6.0) [3–28] n = 14	13.3 (6.3) [8–28] n = 9	12.8 (6.1) [3–18] n = 5
Vitamin D level, nmol/L	67.1 (35.4) [9–139] n = 37	62.1 (37.7) [9–139] n = 16	64.3 (34.5) [17–131] n = 10	58.5 (45.8) [9–139] n = 6
Vitamin D below threshold of 50 nmol/L	37.8% n = 14	50.0% n = 8	50.0% n = 5	50.0% n = 3
Midpoint date of stay	21 November 2014	2 December 2014	22 November 2014	18 December 2014
Mean length of stay, days	81.3	81.3	76.7	89.6

Values are expressed as mean (SD) [range], unless otherwise indicated. [a] p = 0.01 (Kruskal-Wallis nonparametric test).
[1] All patients that had been admitted and discharged during the registration period.
[2] All patients with a unipolar depressed phase or a depressed phase as part of a bipolar disorder who stayed in the same room from admission to discharge.

Table 1 shows the sociodemographic data of the full sample (n = 67; i.e., all patients admitted and discharged during the registration period), the sample fulfilling the inclusion criteria (n = 29), and the sample fulfilling the inclusion criteria according to geographical orientation (i.e., in a NW- or SE-facing room). The distribution of variables was similar across the full sample, the included patients, and the 2 geographical groups.

Table 2 shows the study outcomes. The mean (SD) length of stay was 29.2 (26.8) days in the SE-facing rooms

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compared to 58.8 (42.0) days in the NW-facing rooms (χ^2 6.1; $p = 0.01$). Vitamin D levels were comparable between groups. Half the patients in both groups had vitamin D levels below the recommended level of 50 nmol/L.

Only a minority of patients were evaluated with the HAM-D_{17} both at admission and discharge. Among these patients, we found that score reductions were greater for those staying in SE-facing rooms, i.e., 14.0 (9.8), versus 9.7 (5.4) in the NW-facing rooms, which corresponds to a 52.2 and 42.2% reduction, respectively, in scores from baseline., but this was not statistically significant (p = 0.42). However, it should be noted that this improvement was reached in a shorter time span in the SE group compared to the NW group. When analyzing the speed of improvement (score change/day), we found this was faster in the SE group, but this was not statistically significant ($p = 0.39$).

The mean midpoint of stay for patients was similar in the 2 locations (NW-facing rooms [22 November 2014] vs. SE-facing rooms [18 December 2014]; $p = 0.41$). Furthermore, we used the midpoint of stay to allocate patients to the appropriate season, and investigated the effect of the season on the length of stay. This showed a longer stay in autumn and winter. The mean (SD) values were: autumn 57.1 (46.5) days, winter 50.0 (47.3) days, spring 34.6 (26.5) days, and summer 43.5 (24.1) days (p = 0.75). Even when coalescing autumn with winter and spring with summer into single categories, the impact of season on the length of stay remained insignificant, with the mean length of spring + summer being 37.8 (24.8) days, and autumn + winter being 53.6 (45.6) days (p = 0.46).

Exploratory regression analyses with length of stay as the dependent variable and room orientation, season, HAM-D_{17} scores at admission and discharge, vitamin D levels as independent variables, only revealed a significant effect of geographical room orientation (SE- or NW-facing). We furthermore looked into whether patients were staying in a single or double room, as the nursing staff assumed that more severely ill patients more often were placed in a single room and might have a longer stay. However, we did not have sufficient data for the analysis of the depressed group staying at the same side of the building ($n = 29$) because patients moved between room types in the course of their stay. As an alternative analysis, we looked into the length of stay for the whole sample ($n = 67$), as we assumed that any impact on length of stay caused by room type would be generic and not restricted to any particular diagnosis. We selected patients who stayed in the same type of room throughout their stay ($n = 37$), and further divided them into 2 groups, i.e., they occupied only single or only double rooms. This analysis showed no statistical difference in length of stay between single and double rooms, with a mean of 49.2 (43.9) days for patients staying (for the whole of their stay) in a single room ($n = 8$), and 55.1 (49.9) days for those in a double room ($n = 29$) ($p = 0.63$).

Figure 1 shows the distribution of length of stay for individual patients in the NW- and SE-facing rooms. In the NW-facing rooms, 2 patients had markedly longer stays (158 and 167 days, respectively) whereas the maximum length of stay in the SE-facing rooms was only 80 days. As a sensitivity analysis, we analyzed length of stay without these 2 patients. The mean length of stay was then 29.2 (26.8) days at the SE side and 45.8 (18.9) days at the NW side (χ^2 4.7; $p = 0.03$). This implies that the observed difference in length of stay was not caused by these outliers.

Discussion

The main results were that SE-facing rooms received far more daylight than NW-facing rooms, and that the length of stay was significantly shorter in the SE rooms. The sensitivity analysis indicated that this was not caused by outliers. The sociodemographic data suggest that the 2 groups were comparable and did not differ from the whole group of patients staying in the unit during the 1-year registration period.

There may be unknown mechanisms that separated patients with different characteristics into the 2 geographical sites. For example, the relative number of single rooms compared to double rooms is larger on the NW side, but our analysis of the whole sample did not indicate that this influenced length of stay. Another possible mechanism is that the nurses at the department knew that we were investigating the length of stay according to room location. However, the department is always fully occupied so that as soon as a patient leaves a room, it is immediately occupied by a new patient. Thus, there is never any opportunity for the nurses to selectively place patients.

It is a limitation of the study that we do not have data on the intensity and spectral composition of the total lighting in the patient rooms, as we only measured the daylight coming through the windows. However, as the light fixtures were identical in all the rooms, we do not think that this influenced the results regarding the difference in length of stay in the SE- and NW-facing rooms,

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though it might have had an influence on the general length of stay. In addition, we know that patients in rooms facing the sun do draw the curtains, thus reducing light intensity and changing the spectral distribution. Patients also leave their room and go into other ward rooms and outdoors into the daylight. Thus, the measurement of light coming through the window did not accurately reflect the amount of light received by an individual patient; this might have introduced an unknown bias.

A shorter stay is not necessarily, in itself, proof of better efficacy of a given treatment. Rooms directed towards the sun could be uncomfortably warm or light might, in some cases, cause agitation or visual discomfort that could worsen a patient's condition. However, this was not substantiated by the depression scores that were comparable in the 2 groups.

The small sample size reduces the power of the study and increases type II errors, but it also increases the likelihood of significant effects to be spurious. These results should therefore be replicated in a larger, randomized controlled trial, using clearly defined lighting conditions.

The HAM-D_{17} scores and vitamin D measurements involved a high level of missing data, and so we cannot rule out an unforeseen selection that could have potentially biased the results. The results cannot be generalized to other psychiatric departments without caution.

If our findings were due to a genuinely beneficial effect of light, we should consider the implications, not only for inpatient wards but also for lighting in the private homes of patients with depression. Very little is known about lighting habits in patients' homes. Furthermore, the results should inspire using adequately dosed and timed lighting on inpatient wards. Future larger studies investigating the impact of light on inpatient wards should be conducted. Indeed, we are currently planning a randomized controlled trial with dynamic LED lighting and detailed light measurements.

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