

Daylight Benefits in Healthcare buildings

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Abstract

This paper provides a comprehensive synopsis of research undertaken worldwide associated with the impact of daylight in healthcare buildings. The research findings provide compelling evidence that access to daylight provides; a reduction in the average length of hospital stay, quicker post-operative recovery, reduced requirements for pain relief, quicker recovery from depressive illness and disinfectant qualities. The literature review is generally based on objective, peer-reviewed research findings.

Introduction

During the history of mankind the importance of sunlight and daylight has been recognised and then forgotten several times. Ancient civilisations understood the critical importance of daylight associated with human health, happiness and wellbeing. Following the fall of the Roman Empire, much of this wisdom was lost during the Dark Ages. It wasn't until the mid-19th century that the healing properties of light started being appreciated again by healthcare pioneers, such as Florence Nightingale. The importance of the beneficial therapeutic effects of daylight and sunlight reached new levels of understanding with the treatment of tuberculosis (TB), rickets and jaundice becoming more widely understood in the early 1900's. This important new branch of medicine was referred to as 'heliotherapy.'

A new architectural language and form of expression centred on exploiting and celebrating the virtues of daylight in buildings was championed by architects such as Le Corbusier in the 1920's and embraced by building developers and designers around the world.

No sooner had solar architecture reached a zenith again, than the benefits were to be forgotten as a result of rapid developments in building technology and medicine. The advent of air-conditioning and the introduction in the 1930's of fluorescent lighting enabled architects to design deep buildings, without the need to exploit daylight. This trend was exacerbated by improved public health and in new treatments for TB, coupled with the introduction of antibiotics. As a result, the healing properties of the sun and the benefits of heliotherapy were soon forgotten again.

We now have a legacy of buildings constructed over the past 70 years which rely on artificial light and energy intensive building services to provide habitable conditions. Many of these buildings have a negative impact on human health, productivity and wellbeing. For many occupants, this implies higher levels of stress and in extreme cases the buildings are responsible for debilitating health problems associated with Sick Building Syndrome (SBS).

The issues associated with SBS and/or daylight deprivation, coupled with a renewed interest in the use of daylight in the design of low-energy, sustainable buildings is leading many architects and engineers to consider innovative ways of exploiting the benefits of daylight (and views) without the negative impacts associated with solar over-heating. However, there are concerns that current health implications associated with excessive solar exposure (e.g. skin cancer etc.) could inhibit the re-emergence of a renewed interest in solar architecture. It is critically important that the positive

benefits of daylight do not become confused with the negative impacts associated with excessive solar radiation, not least because modern glazing can reduce the transmission UVs.

Compelling, objective, independent research evidence regarding human health associated with daylight in the healthcare sector is presented in this report.

Impact of daylight on average length of in-patient stay

A number of peer-reviewed independent studies provide evidence that access to daylight enables patients to be discharged from hospital sooner than patients without daylight access.

A study by Choi et al¹. published in 2012, found that;

'A significant relationship appears to exist between indoor daylight environments and a patient's average length of stay (ALOS) in a hospital. 25% of the comparison sets showed that, in the brighter orientations, as in rooms located in the SE area, the ALOS by patients was shorter than that in the NW area by 16%-41%. Further, no dataset showed a shorter patient ALOS in the NW area than in the SE.'

Furthermore, the study concluded that;

'The high illuminance in the morning seemed to be more beneficial than in the afternoon. Patient rooms are oriented to the southeast (SE) and northwest (NW), and admitted daylight was found to be more intense in the SE in the morning and in the NW in the afternoon. However, since short ALOS cases were more consistently found in the SE, it would appear that morning light has a more positive effect than light in the afternoon does, and provides physiological benefits for humans.'

In 2006 a comprehensive review of the impact of light on outcomes in healthcare settings by Anjali Joseph² found that;

'A retrospective study of myocardial infarction patients in a cardiac intensive-care unit treated in either sunny rooms or dull rooms found that female patients stayed a shorter time in sunny rooms (2.3 days in sunny rooms, 3.3 days in dull rooms)³. Mortality in both sexes was consistently higher in dull rooms (39/335 dull, 21/293 sunny).

Another study found that Veterans Health Administration medical centres located in sunnier, warmer and drier climates had shorter length of stay of patients⁴.

Post-operative recovery

A literature review of the effects of natural light on building occupants undertaken by Edwards and Torcellini⁵ states;

¹ Choi JH, Beltran L and Kim H. Impacts of indoor daylight environments on patient average length of stay (ALOS) in a healthcare facility. *Building and Environment* 2012; 50: 65-75

² Joseph A The Impact of Light on Outcomes in Healthcare settings. Issue Paper 2 The Centre for Health Design 2006

³ Beauchemin, K. M., & Hays, P. (1998). Dying in the dark: Sunshine, gender and outcomes in myocardial infarction. *Journal of the Royal Society of Medicine*, 91(7), 352-354.

⁴ Federman, E. J., Drebing, C. E., Boisvert, C., & Penk, W. (2000). Relationship between climate and psychiatric inpatient length of stay in Veterans Health Administration hospitals. *American Journal of Psychiatry*, 157(10),

'Improving the mental well-being of patients improves their recovery rates. Recent studies show that daylight post-surgical facilities improve this mental well-being. Intensive Care Unit (ICU) areas in hospitals can be very stressful for patients and workers⁶). Some patients can develop "post-operative delirium" in a stressful environment, which affects the intellectual ability of the patient. Many factors affect the development of the delirium: age, alcoholism, drug abuse, sex, preoperative anxiety, sleep deprivation, and perceptual distortion). Daylight helps reduce the stress associated with this environment'.

Wilson⁷ conducted a study to see whether windows had an effect on the postoperative delirium rates in hospital units. He found that;

'the windowless ICU had twice as many patients developing post-operative delirium and depression. Windows provided a psychological escape that decreased the stress level for patients. This environment provides a necessary mental balance for patients and reduces the tendency toward brief psychotic episodes. Windows are important in the medical field because they can reduce the stress and depression in patient units.'

Daylight and pain relief

Research has demonstrated a clear link between daylight/sunlight and a reduced requirement for pain relief medication in hospitals. The use of analgesic medication can result in side-effects and for this reason any strategy which reduces the requirement for pain-relief medication is desirable.

A study published in the Journal of Psychosomatic Medicine⁸ in 1995 concluded;

'Consecutive patients undergoing elective spinal surgery who were assigned postoperatively to rooms on either the bright or dim side of the hospital unit. The patients staying on the bright side received 46% more natural sunlight and required 22% less opioid equivalent analgesic medications during their hospitalization. The patients staying on the bright side also experienced a 21% reduction in analgesic medication cost compared with patients on the dim side.'

This is a remarkable finding with significant implications in terms of hospital design, patient care and benefits in terms of reduced medication side-effects treatment cost.

The importance of views from healthcare buildings

Numerous qualitative and quantitative studies have identified and reported the importance of establishing a visual connection with the natural world outside the building. Demonstrable benefits have been found associated with faster post-operative recovery and improved treatment.

⁵ L. Edwards & P. Torcellini, 'A Literature Review of the Effects of Natural Light on Building Occupants' –NREL - July 2002 - <http://www.nrel.gov/docs/fy02osti/30769.pdf>

⁶ Collins, B. "The Psychological Aspects of Lighting: A Review of the Work of CIE TC3.16." Gaithersburg, MD: National Institute of Standards and Technology; 1990.

⁷ Wilson L. Intensive care delirium: The effect of outside deprivation in a windowless unit. Archives of Internal Medicine 1972; 130:225-226.

⁸ Walch JM, Rabin BS, Day R, Williams JN, Choi K and Kang JD. The effect of sunlight on postoperative analgesic medication usage: A prospective study of spinal surgery patients. *Psychosomatic Medicine* 2005; 67(1): 156-163.

In 1995 The New England Journal of Medicine⁹ published a review regarding the importance of patient views. The review concluded that;

- *Connection with nature is highly valued; we prefer views of nature to those of the built environment.*¹⁰
- *In a hospital study, views of nature were associated with reduced stress and fewer health-related complaints among employees.*¹¹
- *Students under the stress of examinations felt better after viewing nature scenes,¹² and prisoners with a view of nature from their cells were less likely to attend sick call than those whose cells did not have such a view.*
- *In a retrospective study of patients who had undergone cholecystectomy, those assigned to rooms with a view of a natural setting had shorter postoperative stays and took fewer analgesic drugs than those whose rooms looked onto a brick wall.*¹³
- *Taken together, these results suggest that views of nature provide therapeutic benefit. Obtaining views of nature requires both the appropriate placement of windows and the availability of natural views. The tendency to eliminate windows from hallways, intensive care units, and other hospital areas must be resisted. Poorly fenestrated rooms have deleterious effects on both patients and staff members, but patients are more severely affected.¹⁴ The window sills should be lower in patient rooms so that the landscape outside can be seen by a patient lying in bed. In addition to providing views, windows admit natural light, which is more changeable, interesting, and informative than artificial illumination.*

In Keep's research (1980)¹⁵ of windowed vs. windowless intensive care units, the windows were translucent thus eliminating view as a variable. He nonetheless discovered that disorientation, hallucinations, loss of memory, and delusions were still significantly less common in the windowed but viewless ICU. The implication is that daylight alone provided critical information, perhaps about time and weather patterns, to the patients which in turn led to stress reduction.

A review of research associated with the impact of daylight and windows on Intensive Care Unit patients and staff by Shepley et al¹⁶ reported that;

⁹ Horsburgh, R Healing by Design. New England Journal of Medicine, 333, September 1995.

¹⁰ Kaplan R, Kaplan S. The experience of nature: a psychological perspective. New York: Cambridge University Press, 1989.

¹¹ Verderber S. Dimensions of person-window transactions in the hospital environment. Environ Behav 1986;18:450-66.

¹² Ulrich RS. Visual landscapes and psychological wellbeing. Landscape Res 1979;4:17-23.

¹³ Ulrich RS. View through a window may influence recovery from surgery. Science 1984;224:420-1.

¹⁴ Verderber S, Reuman D. Windows, views, and health status in hospital therapeutic environments. J Archit Plann Res 1987;4:120-33.

¹⁵ Keep, P., James, J., Inman, M., "Windows in the Intensive Therapy Unit", Anesthesia, Vol 35, 257-262, 1980

¹⁶ Dr Mardelle Shepley AIA, ACHA, LEED AP, Raymond Gerbi, Angela Watson AIA, Stephen Imgrund MD Patient and staff environments: The impact of daylight and windows on ICU patients and staff <http://www.worldhealthdesign.com/Patient-and-staff-environments.aspx>

'In 1972 Wilson¹⁷ compared the incidence of postoperative delirium in patients located in windowed and windowless ICUs. Twice as many windowless patients demonstrated delirium and, among patients with abnormal haemoglobin or blood urea, the incidence was threefold. Hallucinations were more than twice as high in a new windowless unit than in the old unit.'

Empirical and objective research data is now providing support for the considerable body of anecdotal evidence that the benefits are greatly enhanced if the views from windows enable a connection with the natural world to be established (e.g. trees, vegetation, water, and the sky). In particular;

- *Ulrich¹⁸ noted that gall bladder surgery patients who had nature views had a shorter length of stay, took less pain medication and made fewer negative comments than those who had views of a building wall.*
- *Verderber¹⁹ found that windows with high sills, distant from the viewer or obscured by walls and furnishing, were ranked as poorly as having no windows at all.*

It is important to recognise that the benefits associated with views extend to healthcare staff, with doctors and nursing staff displaying lower levels of stress and higher performance in daylit spaces and with views from windows.

Optimum window design and size in healthcare buildings

In her review of patient and staff environments, Shepley summarises the findings from a number of studies associated with window size and design;

- *Markus²⁰ emphasised four factors which influence window design: sunshine, awareness, view and lack of privacy. In his study he noted that being close to a window was highly desirable regardless of the size of the visual field. Keighley⁷ found that satisfaction regarding windows was influenced by area and proportion and the number and width of mullions. The most preferred windows were horizontal apertures occupying 25-30% of the exterior wall.*
- *Roessler²¹ found that unpleasant feelings of enclosure were minimal with a window width of at least 1.5 metres. The ideal was two lateral windows with a total width of 3-4 metres in a six-metre-wide room.*
- *Finnegan and Solomon²² found differences regarding job satisfaction, how interesting the job was perceived to be, physical working conditions and overall experience in favour of windowed spaces.*

¹⁷ Wilson L. Intensive care delirium: The effect of outside deprivation in a windowless unit. Archives of Internal Medicine 1972; 130:225-226.

¹⁸ Ulrich R. View through a window may influence recovery from surgery. Science 1984; 224:420-421.

¹⁹ Verderber S. Dimensions of person-window transactions in the hospital environment. Environment and Behavior 1986; 18(4):450-466.

²⁰ Markus T. The function of windows. Building Science 1967; 2:97-121

²¹ Roessler G. The psychological function of windows for the visual communication between the interior of rooms with permanent supplementary artificial lighting and the exterior. Lighting Research & Technology 1980; 12 (3):160-168

²² Finnegan M, Solomon L. Work attitudes in windowed vs windowless environments. Journal of Social Psychology 1981; 115:291-292.

- Ne'eman²³ noted the following positive contributions of sunshine: warmth, functional lighting, contact with the outside and biological effects of solar radiation. He found that 2% of patients and 62% of staff considered sunlight to be a nuisance, while 91% of patients and 31% of staff considered sunlight to be pleasurable. In hospitals, when forced to choose between good views without indoor sunshine and unpleasant views with indoor sunshine, 50% preferred the former while 31% preferred the latter.

Treatment of depression and depressive illness

In the review of the Impact of Light on Outcomes in Healthcare settings Joseph reports that;

- At least 11 strong studies suggest that bright light is effective in reducing depression among patients with bipolar disorder or seasonal affective disorder (SAD). A majority of the studies have examined the impact of artificial bright light on reducing depression. Artificial light treatments usually range between 2,500 lux and 10,000 lux²⁴. The treatment is believed to be effective by suppressing the onset of melatonin.
- Two studies have shown that exposure to natural bright light is similarly effective in reducing depression^{25/26}.

Benedetti and colleague²⁷ found that bipolar depressed inpatients in east-facing rooms (exposed to bright light in the morning) stayed an average of 3.67 days less in the hospital compared with similar patients who stayed in west-facing rooms.

There is strong evidence that exposure to bright light in the morning is more effective than exposure to bright light in the evening in reducing depression²⁸. An experimental study that compared the effect of morning and evening light on patients with winter depression found that morning light was twice as effective as evening light in treating SAD²⁹

Reducing patient stress and agitation.

Sloane and colleagues³⁰ found that residents in facilities with low light levels displayed higher agitation levels.

²³ Ne'eman E. Visual aspects of sunlight in buildings. *Lighting Research and Technology* 1974; 6 (3):159-164.

²⁴ Terman, J. S., Terman, M., Lo, E.-S., & Cooper, T. B. (2001). Circadian time of morning light administration and therapeutic response in winter depression. *Archives of General Psychiatry*, 58(1), 69–75.

²⁵ Eastman, C. I., Young, M. A., Fogg, L. F., Liu, L., & Meaden, P. M. (1998). Bright light treatment of winter depression. *Archives of General Psychiatry*, 55(10), 883.

²⁶ Lovell, B. B., Ancoli-Israel, S., & Gevirtz, R. (1995). Effect of bright light treatment on agitated behavior in institutionalized elderly subjects. *Psychiatry Research*, 57(1), 7–12.

²⁷ Benedetti, F., Colombo, C., Barbini, B., Campori, E., & Smeraldi, E. (2001). Morning sunlight reduces length of hospitalization in bipolar depression. *Journal of Affective Disorders*, 62(3), 221–223.

²⁸ Oren, D. A., Wisner, K. L., Spinelli, M., & Epperson, N. (2002). An open trial of morning light therapy for treatment of antepartum depression. *American Journal of Psychiatry*, 159(4), 666.

²⁹ Lewy, A. J., Bauer, V. K., Cutler, N. L., Sack, R. L., Ahmed, S., Thomas, K. H., et al. (1998). Morning vs. evening light treatment of patients with winter depression. *Archives of General Psychiatry*, 55(10), 890–896.

³⁰ Sloane, P. D., Mitchell, C. M., Preisser, J., Phillips, C., Commander, C., & Burker, E. (1998). Environmental correlates of resident agitation in Alzheimer's disease special care units. *Journal of the American Geriatrics Society*, 46, 862-869.

Exposure to bright morning light has been shown to reduce agitation among elderly patients with dementia. When elderly patients with dementia were exposed to 2,500 lux for 2 hours in the morning for two 10-day periods, their agitation reduced. Patients were significantly more agitated on non-treatment days³¹.

Sunlight –nature’s disinfectant

Experiments undertaken in the USA and the UK between 1941 and 1944 demonstrated the extraordinary and remarkable effectiveness of daylight in killing the bacteria streptococci³². The blue light in skylight was found to be particularly potent. The trials also examined the bactericidal effects of artificial light, which was found to have little value as a disinfecting agent.

Even diffuse daylight passing through two layers of glass from a north window was found to be highly effective in killing haemolytic streptococci within 13 days, with the same strain surviving in the dark, at room temperature, for 195 days.

Hobday, who has researched this issue extensively, reports that no significant further work on this issue has been undertaken since the mid-1940’s. This is surprising given the current concerns regarding methicillin-resistant *staphylococcus aureus* MRSA and other other highly infectious bacteria prevalent in many hospitals, which are becoming increasingly resistant to treatment with commonly prescribed antibiotics. It is interesting to reflect that if daylight has such a dramatic and potent impact on killing streptococci, it’s surprising that its potential for reducing super-bug infections in hospitals, has not been fully investigated.

Daylight, obesity and heart disease

Obesity is reaching epidemic proportions in many developed countries. Considerable research evidence links obesity to depressive illness. Morbidly obese individuals seldom leave home and it is self-evident that their exposure to daylight and sunlight is likely to be severely restricted. Sunlight is essential for the production of Vitamin D. Experiments have shown that obesity is associated with Vitamin D deficiency with the human body accumulating fat as Vitamin D levels fall. The strong causal link between depression and inadequate access to daylight and sunlight has been demonstrated repeatedly –more research is required, but access to adequate levels of daylight and sunlight may prove to be useful in the treatment of obesity.

Sunlight and/or daylight may also have an important role to play in the prevention and treatment of heart disease. In his book *The Light Revolution, Health, Architecture and the Sun*, Hobday speculates that;

‘Sunlight may prevent heart attacks in a similar manner to antidepressants by alleviating depressive symptomsRegardless of the exact mechanisms involved the fact that being in a sunlit ward may have health benefits is a significant finding, which has profound implications not the least of which is the patients’ survival from life-threatening conditions’.

³¹ Lovell, B. B., Ancoli-Israel, S., & Gevirtz, R. (1995). Effect of bright light treatment on agitated behavior in institutionalized elderly subjects. *Psychiatry Research*, 57(1), 7–12.

³² Buchbinder L. et al. Studies on microorganisms in simulated room environments. The Survival rates of streptococci in the presence of natural daylight and artificial illumination. *J Bacteriol* 1942;42(5):545-555

Conclusions

The majority of peer-reviewed research associated with the benefits of daylight has been undertaken in healthcare and educational buildings, where the body of evidence is clear and compelling. Research has also been undertaken associated the workplace and in retail buildings which confirm the findings from healthcare and educational establishments³³.

The key findings have demonstrated that in healthcare, access to daylight provides; a reduction in the average length of hospital stay, quicker post-operative recovery, reduced requirements for pain relief, quicker recovery from depressive illness and disinfectant qualities. There is also a growing body of evidence that daylight plays a critically important role in the prevention and treatment of obesity, heart disease and other illnesses exacerbated by stress.

In buildings of all types, studies show that occupants' value very highly views from windows (ideally of the natural world). The impact on staff stress reduction, patient outcomes and educational attainment are all clearly established and demonstrably linked to being able to establish a visual link from inside a building to the world outside.

Daylight deprivation in buildings has been shown to have hugely damaging consequences. Without access to daylight the human body-clock becomes disrupted –it needs recalibration on a daily basis and unless we receive adequate daylight overwhelming medical evidence suggests that humans become stressful and agitated. Any disruption to our circadian rhythm has highly negative consequences in terms of our health, happiness and wellbeing.

Daylight has a key role to play in enabling the construction of buildings which are sustainable from an environmental, social and economic perspective. Designers sometimes neglect the social impacts of sustainability. The provision of adequate daylight and establishing views to the natural world through appropriately sized and positioned glazing is of fundamental importance –genuinely sustainable buildings must not only reduce environmental impact, they must also be fit for people.

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³³ The social and economic contributions of glazed areas to sustainability in the built environment
Prof. DTG Strong 12th Nov. 2012 Report published by Glass for Europe
http://www.glassforeurope.com/images/cont/225_12633_file.pdf