



the

eFFECTS

of Evidence-Based Lighting Design

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● LIGHT AND DARKNESS IN SENIOR CARE

It is becoming increasingly clear that light and darkness should be part of the care plan for residents in long-term care. Over the last 10 years, researchers have made a number of discoveries that point to the human need for a regular pattern of light and darkness to keep our internal clock in sync with the natural light/dark cycle.

In our natural state (some 200,000 years ago) humans spent most of the day outdoors, hunting and gathering for food. Over the course of the day we would be exposed to hours of bright light, measuring as much as 10,000 footcandles¹. At night we slept in temporary shelters, built to support a nomadic lifestyle. And the night was dark—the moon and stars providing just enough light to see.

● LIGHT AND THE CIRCADIAN RHYTHM

The word “circadian” was coined from two Latin words: “circa,” meaning close to, or about; and “dia” for day. A circadian rhythm is one that repeats each day. Each day our central clock, located deep inside the brain, sends signals to major organs, the digestive tract, and glands that synthesize and secrete hormones and neurotransmitters for behavior regulation. The signals and the behavior are rhythmic—they take place each day at about the same time (if you are healthy), and thus are called circadian.

The most obvious daily rhythm is our sleep/wake cycle. Most of us tend to get up in the morning and go to bed at night on a fairly regular schedule—although in today’s world this is driven by social schedules like the start of work or school rather than the natural light/dark cycle. We also eat at about the same time each day, and fast through the night. Less obvious rhythms include the cascade of chemical reactions fundamental to living organisms. Hormones that affect our brain, enzymes used in digestion, and countless other processes, all are orchestrated by our central clock. For reasons not entirely understood, our clock runs long—about 24.5 hours. In order to keep in sync, they require maintenance.

At first blush, 30 extra minutes doesn’t seem like much, but over the course of time it builds up. If your clock does not get re-set, after a week you might be three hours off, and in less than a month you will be 12 hours out of sync with the clock on

● DARKNESS, MELATONIN, AND SLEEP

But it’s not just the light—darkness is just as important to our health. A number of vital processes occur only at night, and in the dark. During sleep, the body and mind rest and rejuvenate. In the brain, memories are consolidated, and a cleansing process flushes potentially toxic molecules away. The central clock slows down, sending just a few periodic signals. The hormone melatonin is then secreted into the bloodstream.

Fast forward to today and the difference in how we live our lives is shocking. In fully developed countries, most people spend 90 percent of their time indoors, where light levels typically top out at 50 footcandles (standard for an office). At home, levels are far less, usually 10 to 20 footcandles. One survey of light levels in long-term care facilities in California found a mean value of just 5 footcandles. This is not enough light to set your internal clock.

The saving grace for most of us is that we get outside once in a while—we walk in the sun, go to the beach, or have lunch on the terrace. This seems to be enough for a healthy person to at least maintain basic biological rhythms. However, since residents in long-term care may spend extended periods of time indoors, their exposure to bright light may be less.

the wall. A great example of this is the scientists who spend the winter at polar research centers and report great difficulty in keeping a schedule. Individuals who are totally blind also have difficulty since they continually slide into and out of sync with the rest of the world. What is behind their problem is light, or rather the lack of it. While there are several other environmental cues that can contribute, it is primarily light that resets our clock each day.

Bright light at the eye is converted into nervous impulses that are carried directly to our central clock in one of the oldest parts of the brain: the hypothalamus. As the seasons change, the clock is reset a few minutes earlier or later each day to keep us in sync with the natural light/dark cycle. At least, that was how it used to be before Edison patented his electric light bulb in 1880. Electric light changed how we live our lives by allowing us to extend the day into the night

It is important to recognize that, biologically, we are essentially the same animal we were 200,000 years ago. Although our knowledge has expanded, and our technology has advanced, anatomically, we are essentially the same animal that evolved outdoors. However, we now live indoors in an artificial environment illuminated with electric light. This profound change in civilization happened in just 135 years—far too fast for us to adapt.

Melatonin is a truly remarkable hormone which plays a role in a number of functions including regeneration and sleep. It is also the chemical messenger of night. When melatonin is present in high concentrations, clock genes through the body respond so that vital nighttime functions proceed. And here’s the thing: light suppresses melatonin.

¹ According to Dictionary.com, a footcandle is “a unit of illuminance or illumination, equivalent to the illumination produced by a source of one candle at a distance of one foot and equal to one lumen incident per square foot.”

When we are exposed to artificial light at night, the clock begins to awaken after just a few minutes and melatonin is suppressed. We become more alert as the brain begins to awaken and, depending on the quantity of light and what time it is, the clock can be reset to the wrong time of day. This is how light at night can disrupt our system. And when the day is spent in relatively dim indoor light, the combination can result in circadian disruption. Most of us get outside now and again, where we are exposed to bright light, but residents in long-term care may not get enough light during the day, and may get too much light at night.

The symptoms of circadian disruption include cognitive decline, being awake at night, frequent napping during the day, and being hungry at odd times. Sound familiar? This is the profile of many residents in long-term care. In an attempt to mitigate this, a number of scientific studies have investigated how the lighted environment contributes to disturbed circadian rhythms.

Scientists at the Netherlands Institute of Neuroscience have conducted a study in which a large number of residents with dementia participated². The participants were divided into four

groups: in the day room of group one, large light fixtures were installed to provide bright light (100 footcandles measured at the eye) from 9:00am to 6:00pm. A second group was given melatonin in the evening. A third group got the light and the melatonin. The fourth group was the control—they got a placebo pill and light fixtures without any light bulbs.

The results were encouraging. Light attenuated cognitive deterioration by a relative 5 percent and ameliorated depressive symptoms by a relative 19 percent. Light also attenuated the decrease in functional limitation over time by 1.8 points per year—a relative 53 percent difference. Melatonin, in combination with bright light, attenuated agitated behavior by 9 percent (this approaches results attained with pharmacology). They also found increasing benefits to sleep, which if they were sustained over time, could help maintain sleep efficiency above 85 percent, the cutoff for clinically relevant disturbed sleep. And if that's not enough, those in the experimental group lived longer.

So, how can we use this knowledge to improve outcomes for residents? The answer is a better building—one that delivers more light during the day and more darkness at night.

● USING LIGHT AND DARKNESS TO BUILD A BETTER BUILDING

The design of long-term care communities must consider these lighting principles and the effects of too much or too little light influence upon residents' circadian rhythms, safety, and well-being. Too much light can be distracting and cause glare. Confusing light patterns shining in on walls and floors can be hazardous for seniors with vision problems.

Too little light, however, may be just as dangerous as it contributes to trips and falls if areas are not adequately lit. Providing the necessary amounts of light at the correct times of the day is equally important for architects and lighting designers to consider in senior communities. The 24-hour light/dark cycle is the most important consideration in maintaining residents' daily routines and normal, healthy sleep patterns.

The more closely that indoor spaces can replicate the patterns of natural outdoor light directly relates to better health in residents. Daylight exposure provides better sleep quality, promotes vitamin D synthesis for healthy bones, prevents depression, and reduces agitation. When designing new communities, optimizing the building footprint to efficiently maximize sun exposure can be a powerful strategy. Including sun rooms, skylights, clerestory windows, tubular daylighting devices, and daylight-responsive electric lighting controls are all appropriate options in new and existing construction.

With new technology at our fingertips, lighting control companies such as Lutron are providing systems for total light control. Daylight sensors can automatically adjust shades and overhead lights to maintain lighting levels during the day. More sophisticated systems can store schemes in which you

may control multiple lights to certain levels. With the touch of a button these systems can be programmed to dim multiple lights to various levels depending on user preference, or the system can be programmed to automatically transition during the day.

Designing for darkness or nighttime lighting is important as well—for instance, corridor lighting is always needed so that caregivers can safely navigate hallways in order to provide care for residents but too much can negatively impact the circadian rhythm. Therefore, resident rooms should be positioned to avoid the effects of hallway lighting at night.

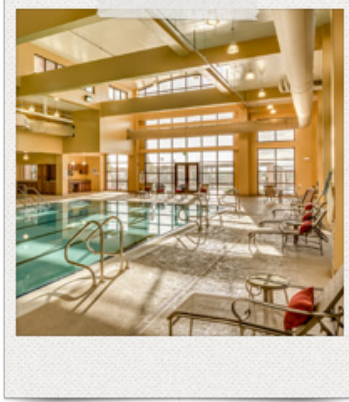
In addition, by working with caregivers to address appropriate nighttime lighting, combined with meeting requirements for safety and egress, designers can assist in assuring that residents are not receiving too much light at night. Within resident rooms, nightlights to accent walkways may be helpful for safe navigation in the middle of the night while at the same time allowing residents to maintain a good night's rest.

Floor patterns should also be considered. As seniors age, their perception, senses, mobility, and eye function changes. The necessity for increased illumination and greater contrast between objects and the background is required to prevent confusion and maintain autonomy. Therefore, floor patterns should be simple; stripes or extremely busy patterns which make navigation difficult should be avoided. Also, the distinction where floor surfaces and walls meet should be easily interpreted and understood.

² Riemersma-van der Lek et al. "Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities." *The Journal of the American Medical Association* 299.22 (2008): 2642-2655.

● LIGHTING DESIGN IN PRACTICE

A selection of recent projects we have completed provide examples of well-lit spaces that maximize natural light and contribute to healthy, active lifestyles of residents.

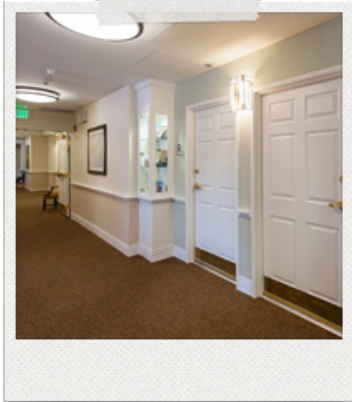


The indoor aquatic center at Nueva Vista at La Vida Llena, located in Albuquerque, New Mexico, feels more like an outdoor space as the space is flooded with natural light throughout the daytime hours. It is designed with a floor-to-ceiling curtain wall in a double-height space. Lamps were also designed for early morning/evening times. Light illuminates and energizes this space built for seniors leading healthy, active lives. In addition to establishing excitement and attracting seniors, this type of lighting design has the potential to cut energy consumption for artificial lighting.

Clerestory windows in a memory care living and dining room at Bradford Square, a Vintage Senior Living community in Placentia, provide ample, even daylight and draw residents out of their rooms to socialize and connect with each other. The french doors which look upon and lead to the outdoor Discovery Garden are flanked by two windows. The adjacency of the living and dining room to the garden is important for memory care residents as it welcomes and encourages residents to go outdoors. The exposure to natural daylight both indoors and outdoors, combined with the exercise residents will achieve by strolling outside along the meandering path in the garden, lead to greater autonomy and healthier lives.



Corridor lighting is important, as it provides the pathway for residents to get to and from their rooms and to activity and common spaces. Corridors do not have to be long, narrow, and uninteresting. Well-illuminated sitting nooks, artwork walls, and memory boxes provide interest and keep corridors lively, as in this Brookdale Ventana Canyon building in Tucson, Arizona.



Thoughtfully applied lighting design does indeed have a positive impact on several aspects of resident well-being and continues to demonstrate a powerful contribution to their experience. It can reduce environmental stress, reinforce orientation and way finding, and create interest and delight as individuals interact with the built environment. Consideration of these principals early in the design process will consistently result in the highest quality environments for our elders. ■

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Photos Courtesy of Douglas Pancake Architects, Inc.

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