

The Effects of Lighting and Reflectivity in Healthcare Settings

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It has been proven that exposure to sufficient levels of lighting in healthcare facilities has a strong positive impact on all aspects of the patient experience—aiding in wayfinding, improving moods and promoting comfort, wellness and healing. But lighting has its benefits for healthcare staff as well. It has been found to increase satisfaction levels in the work environment, improve staff moods and decrease the potential for medical errors. When we look at the different ways lighting affects both patients and staff, we begin to see the importance of incorporating flooring with high light reflectance values into the various spaces to help harvest natural sunlight and increase illumination.

Impacts of Lighting on Patients

There are a number of ways in which lighting plays a significant role in a patient's well-being.

Pain Management: A 2005 randomized prospective study was conducted to determine whether the amount of sunlight in a hospital room influenced a surgery patient's psychosocial health and affected the amount of pain medication used. Postoperatively, patients were admitted to rooms on either the brighter side of the hospital or the dimmer side. The study found that postoperative patients who were placed in rooms on the brighter side of the hospital were exposed to an average of 46% higher intensity sunlight. These patients experienced less perceived stress, marginally less pain, and took 22% less pain medication per hour than the patients on the dimmer side of the hospital.¹

Depression: A considerable amount of meticulous research indicates that exposure to light—daylight or bright artificial light—is effective in decreasing depression among patients with bipolar disorder or seasonal affective disorder resulting in less time spent in the hospital.

Length of Hospital Stay: Research shows that among hospital patients suffering from depression,

those who stay in rooms with brighter sunlight stay a shorter duration of time. Additionally, a study of myocardial infarction patients treated in either sunny or dull rooms found that patients who were in rooms with more sunlight stayed a shorter time than those who were in rooms with more subdued lighting, with a more favorable reduction in stay for females. Mortality rates were found to be consistently higher in patients of both sexes who were in more subdued rooms.

Patient Sleep: Lighting plays a large part in normal circadian rhythm, which synchronizes the body's internal clock to 24 hours. The amount of light that patients are exposed to at different times of the day can affect their circadian rhythm and impact their sleep quality. To ensure good quality sleep, patients should be exposed to adequate natural light during the day, or bright artificial lighting when natural light is not available.

Agitation: Studies show that in healthcare facilities with low light levels, residents displayed higher levels of agitation. Exposure to bright morning light has been shown to reduce agitation among elderly patients with dementia.²

Wayfinding: Living beings instinctively move toward light. For this reason, lighting is an effective way to assist with wayfinding, making it easier to navigate corridors and complicated spaces. Many hospital patients and visitors may already be dealing with physical impairments or disabilities. Add to that the challenge of trying to find their way through a large facility and the outcome could be a stressed and unpleasant experience. Aside from corridors, elevator lobbies and exit stairs should also be illuminated more brightly than adjacent spaces or patient care areas to provide wayfinding cues.

Patient Satisfaction: Sufficient lighting has been identified as a positive component in patients' overall satisfaction with their time spent in the hospital.

Impacts of Lighting on Healthcare Staff

For healthcare staff, lighting has different impacts.

Circadian Rhythm: When the body's internal circadian rhythms do not align with the workday rhythms, an individual can feel tired, drowsy and distracted. This is often the case with many healthcare staff who work at night. For example, for staff working at night, a 24-hour cycle that would keep most people awake and alert during the day, and sleepy at night, would result in fatigue and a compromised ability to perform during the night shift.³ Several studies have found that circadian rhythms of night-shift workers can be adapted through sporadic exposure to bright light during the night shift.

**Lighting Benefits
for Healthcare Staff**

- 
Helps align circadian rhythm
- 
Reduces medical errors
- 
Improves job satisfaction

Medical Errors: Research has found that errors in dispensing medication are lower with relatively high levels of work-surface lighting as compared to environments with lower levels of lighting. Healthcare staff working at night, often experience sleep loss and misalignment of circadian rhythm resulting in decreased performance, alertness and attentiveness, which may cause more errors on the job.

Job Satisfaction: Studies show that access to sufficient natural light for healthcare staff has the most positive environmental impact on their work life. Staff with more than 3 hours of daylight exposure during their shift tend to have higher job satisfaction than staff with less daylight exposure.

Evidence-Based Design

It is becoming evident that daylight is essential to our health and physical and mental well-being. Numerous studies and significant research findings have provided enough evidence to call attention to the benefits of incorporating more natural light into healthcare facilities. Evidence-based design (EBD) is a field of study that emphasizes the importance of this type of credible evidence to influence building design. It is an approach that has become popular in healthcare to improve patient and staff well-being, patient comfort and healing, stress reduction and a decrease in the length of hospital stays.

Natural light is one of 12 aspects of a healing environment, identified by design professionals using EBD, that have the ability to be part of the healing process. Several years ago, it would have seemed costly, and of no value, to introduce daylight into a large institutional facility. Today research supports a different point of view, providing more freedom for design teams to utilize daylight as a standard light source for interiors. And lighting is an essential design element influencing the staff, patient and visitor's perception of the hospital experience.

Visual Comfort and Glare

All materials reflect light, with light colors reflecting more light than dark colors. Smooth surfaces reflect light directly whereas textured surfaces scatter the light causing it to be less bright in one area. When a large amount of light is directionally reflected, glare can result. The eye perceives glare when the luminosity in the visual field is greater than the luminosity to which the eyes are adapted. This can result in discomfort, visual impairment or both.

There are two types of glare: direct and indirect. Direct glare results when a high light source, like the sun, is present in the field of view. Indirect, or reflected glare, results from the reflection of high-brightness in a polished surface such as the reflection of the sun off of a mirror. Smooth surfaces are more likely to cause direct glare than textured surfaces. In most healthcare settings, flooring with textured, non-glossy or matte finishes are preferable to highly polished surfaces. This is especially true in senior or assisted living facilities. As we age, less light reaches the back of the eyes, our pupils get smaller and the lenses inside the eyes become thicker, absorbing and scattering more light and adding a "luminous veil" over images on the retina. These vision impairments raise safety concerns for the senior population. They reduce the contrast and sharpness of objects, the vividness of colors and require considerably more light for seniors to see properly than their younger counterparts. Because seniors require higher light illuminance, freedom from glare and enhanced luminance or chromatic contrasts, flooring surfaces in corridors and common areas of senior living facilities should not contain strong or highly contrasting patterns and highly reflective flooring should be avoided.

Flooring Light Reflectance Values

Bright spaces aren't just about light sources — they are about integrated systems. The use of flooring with high light reflectance values increases operational efficiencies in a healthcare facility by maximizing the inputs of the artificial and natural light sources to increase illumination in the space without the use of additional energy. In fact, the use of flooring with high light reflectance values can decrease artificial lighting needs resulting in energy cost savings.

Traditionally it has been the belief that wall and ceiling reflectivity more significantly impacts the luminance of a space than flooring, but research indicates flooring is an effective surface for efficiently reflecting light.

While hospital beds, equipment and patient room furniture do cover areas of the floor, they do not provide complete coverage and do not interfere with the floor's ability to reflect light any more than curtains and mounted equipment interfere with the reflectivity of walls against which they are placed.

Light Reflectance Value (LRV) is the total quantity of visible and usable light reflected by a surface in all directions and at all wavelengths when illuminated by a light source.⁴ Light reflectance values of flooring, and other surfaces within the space, significantly impact both natural light and artificial lighting distribution. On a scale of 0% to 100% a light reflectance value of 0 represents total

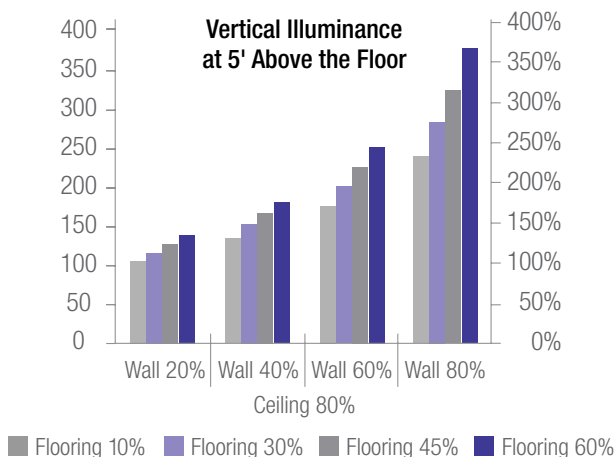
surface light absorption and 100 indicates total light reflection. When higher reflectance flooring is used, more light, from all sources, is reflected back into the space, and luminance levels are increased. Rather than adding more lighting assemblies or increasing the intensity of existing units, utilizing light-reflective surfaces is a cost-effective way to improve illumination.

The Illumination Engineering Society of North America recommends light reflectance values for flooring from 20 to 30% in operating rooms. Flooring products that have at least a 25% surface light reflectance value can contribute to LEED® v4 IEQ Interior Lighting Credit.⁵

A recent study completed at Pennsylvania State University, “The Impacts of High Reflectance Flooring Materials in Healthcare Applications,” reported by Richard G. Mistrick, Associate Professor of Architectural Engineering, and Ling Chen, a Graduate Research Assistant, looks at the impact of flooring with high light reflectance values on the operating lighting energy and lighting quality in a healthcare setting such as a hospital or medical facility. The study covered four different types of spaces—a corridor, patient room, exam room and cardiac catheterization lab. In each of these settings, researchers assessed the horizontal and vertical illuminance levels of a representative area of the spaces. Horizontal illuminance is the amount of light falling onto a horizontal surface, such as the floor, and vertical illuminance describes the illuminance landing on a vertical surface, such as a wall.

For the study, lighting conditions in each of the settings were measured for floor reflectance values of 10, 30, 45 and 60%; wall reflectance values of 20, 40, 60 and 80%; and ceiling reflectance values of 60 and 80%. Differences in the average values were evaluated to determine the potential for energy savings as the floor reflectance changed, relative to the expected performance with a 20% reflectance floor. Study results indicate as the light reflectance value of the flooring increased so did the illumination levels of the spaces. (See Figure 1.)

Figure 1: Vertical Illuminance in a Hospital Corridor



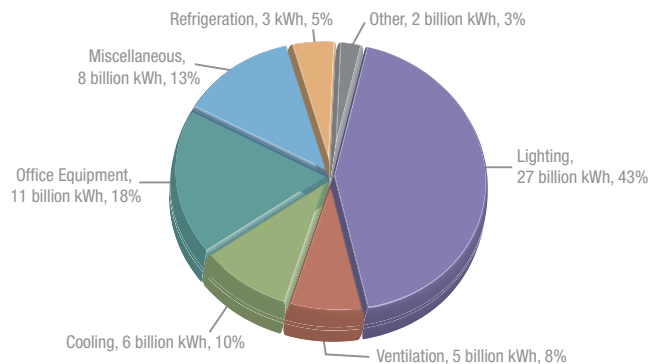
The findings conclude that higher reflectance flooring can increase illuminance levels for a given lighting system, reducing energy consumption and resulting in energy savings for a space design that is finely tuned to achieve a specific target illuminance level.

The lighting improvement will be more substantial in spaces that have higher-reflectance ceilings and perimeter walls. As the study shows, illuminance increases steadily as illuminance of ceilings and walls increases. The greatest increases in luminance occurred in spaces where the ceiling and walls had reflectance values of 80%. It’s not so much the lighting or the light source that effectively increases luminance but the amount of light available for the space. This can be increased from floor reflectivity.

Reducing Energy Costs

Lighting is one of the single largest consumers of electricity in hospitals, representing an average of 16% of total energy consumption and about 27 billion kWh or 43% of annual electricity use. (See Figure 2.) Specifying flooring with high light reflectance values provides opportunity to reduce energy costs by maximizing available light throughout the space.

Figure 2: Electricity Usage in Hospitals⁶



To ensure light is sufficiently reflected throughout the space select lighter colored flooring. Avoid extremely dark colored flooring materials, as these surfaces can require more installed lighting power to meet illuminance levels, resulting in higher costs. Reflectance will vary based on the type and color of the surface. (See Figure 3.)

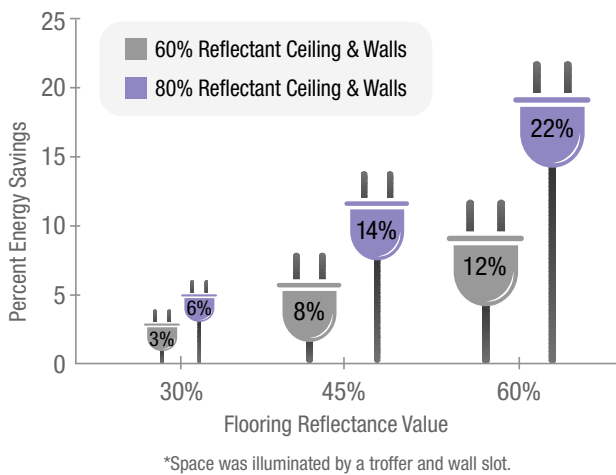
Figure 3: Luminance Differences in Space with 60% Reflectant Floor vs. 30% Reflectant Floor



In the state of California, spaces larger than 5,000 sq. ft. are required under Title 24, §140.3(c) to utilize daylighting as a means to reduce energy costs. As research shows, flooring with high light reflectance values can increase daylighting levels, and where daylighting is not a factor, can result in more efficient distribution of artificial light. Either outcome would enable medical facilities to create brighter spaces, use less electricity and reduce energy costs improving the bottom line. Spaces with high-reflectance ceilings and walls will result in higher luminance and yield even greater savings.

In a hospital corridor, where the reflectance value of flooring material was raised from 20% to 30, 45 and 60%, the Penn State study showed electricity savings amounted to about 3 to 22% of the lighting energy that would otherwise be consumed depending upon the reflectance of the ceiling and the walls. (See Figure 4.)

Figure 4: Percent Energy Savings Relative to 20% Floor Reflectance for a Hospital Corridor



Wall reflectance can increase the interreflections within a space having a significant impact on high reflectance flooring. When the wall reflectance is 80% versus 40%, the savings between a 20% and 60% reflective floor more than double.

Insights

A well-illuminated healthcare facility is critical for the health and well-being of both patients and the healthcare staff. For patients, light has been found to support the healing process by alleviating pain, reducing depression, improving sleep and circadian rhythms and, for certain patients, reducing the length of their hospital stay. For healthcare staff access to bright light or daylight contributes to adaptive circadian rhythms, higher job satisfaction and improved performance of critical tasks such as medication dispensing.

While healthcare facilities are lit by a combination of electric lighting and natural daylight, there is a strong preference for daylight. Electric light is needed throughout all parts of the building, however, to illuminate spaces where natural light cannot be present. The need

for artificial lighting can be reduced, not only by efficient utilization of sunlight wherever possible, but by the use of flooring with high light reflectance values. Through the use of daylight, which is delivered at no cost, and flooring with high light reflectance values, healthcare facilities can improve patient outcomes and staff performance and reduce their electricity usage, positively impacting the facility's bottom line. Flooring with a high light reflectance values can provide an energy savings opportunity, however lighting designers must first address the well-being of occupants through factors such as visual comfort and occupant safety.

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