Light, Daylight and Health

Two metrics used most widely for the performance of a hospital are the rates that patients improve, and the productivity of its employees. In a chronically stressful work environment, quality lighting has a profound impact on these matters through its impact on overall health, satisfaction and productivity for staff, patients, and visitors. This is particularly true in the case of providing access to daylight. Light has a significant impact on our quality of life, and impacts our perception of a quality environment. Most research to date has focused on our visual response to light and its effect on our functional vision and task performance. Recent discoveries in photobiology, however, highlight the fact that daylight also has a significant impact on human health. This research underscores the importance of incorporating natural light into the built environment, especially in hospitals. Significant to these findings, is the importance of the cyclical nature of light, the specific spectrum of light and the intensity of light that people are exposed to.

People used to work in the day and sleep at night. With the advent of the industrial age and "night" lighting, we have slowly, but surely, taken over the night as a time of wakefulness, and therefore work. Today, people are nearly as likely to be working or playing at night as they are in the day. As our wakeful hours shift deeper into the night, or similarly as we work farther and farther from daylight during the day, we are seeing that there are photo-biological implications for our health and wellness. There are two dimensions to the relationship between light and health, the role of vision with visible light and "what we commonly see", and the affects non-visible light on what we don't "see." This non-visual aspect may not be "seen," but it greatly affects human chronobiology and the endocrine system.

Vision & Visible Light: We are dominantly visual beings. As much as 80% of our perception of the world around us occurs through our sight. Providing the most appropriate quantity, and the best quality of light are keys to a productive and healthy healing environment. An electric light fixture, mounted on the ceiling of a patient's room, at a nurse's station, or in a non-clinical staff office can commonly provide the same amount of light as a window with a view. If lighting is considered only within the dimension of the quantity of light provided, electric and natural sources of light might compare favorably. If considered more appropriately, there are multiple critical dimensions to visual and non-visual perception of light, and therefore, quality lighting: looking to or through a source of light to what views it provides for visual relief from chronic stress, what environmental information you get from that source of light, what the spectral quality of the light is, and how the light source varies over time and across a space as it is appropriate of a particular task. We propose that as a goal, quality lighting should:

:: Enhance seeing and provide views of nature in all healing spaces, and spaces where staff work for more than several hours.

:: Design windows and their immediate surrounding spaces as a critical interior spatial light sources and access portals to the exterior environment. In this way, the interior and exterior space fuse and the exterior space becomes a healing landscape throughout the hospital. Acknowledge the critical role of views to nature in reducing chronic stress. Achieving this goal will provide views of the outdoors that link patients and staff to outside environmental information through observations of the day's weather and daily or seasonal variability in the rich landscape of plants and changing daylight.

:: Emphasize the natural variation of daylight during different times of the day: the range of color, spectral variation, during early morning, late afternoon, in the shoulder periods and during the night is ever changing throughout the day. Design the building and its landscape to emphasize the role of the daily varying spectral quality, color, of light as the time of day changes. The spectral quality of light is a critical consideration when designing a healing environment.

:: Express the varying tasks within the hospital environment appropriately for the functional program. In very close proximity, view may or may not be appropriate, very high levels of illumination may be needed to deliver critical medical services such as prescriptions, while nearly simultaneously, extremely low levels of illumination are needed to support healing sleep. These often conflicting space-by-space, moment-by-moment, distinctions for the variable needs of light need to be expressed in a quality lighting design for a healthful workplace and healing environment.

Vision and Non-Visible Light: In 2002 a novel, non-visual, photocell has been discovered in the human eye (Berson 2002). This retinal ganglion receptor is essential for mediating bodily rhythms and systems and is regulated primarily by light and dark cycles. Thus, our eye is mediating two parallel responses to light; one for vision and one for physiological regulation. This new non-optical receptor is connected through its own pathway through the superchiasmatic nucleus in the brain, and triggers a multi-synaptic light induced pathway that communicates to other non-visual parts of the nervous system. This process acts as a clock, oscillating on daily (circadian) and seasonal (circannual) rhythms.

Many physiological responses are activated and regulated by light entering the eye and triggering this non-visual photoreceptor. For example, body temperature, and the hormones cortisol and melatonin are regulated through this process. These two hormones play important roles in governing alertness, sleep, regulating blood sugar, and maintaining the immune system. An imbalance in these hormones over a long period exhausts the system causing fatigue, stress, and loss in the body's homeostatic balance. In a natural setting, where we have access to natural light, the body synchronizes its internal clock to the changing nature of sunlight. In environments where we have less access to natural light, these biological systems can be disrupted significantly. In a recent study of nurses, night shift work has been associated with increased risk for cancer (Dimich-Ward, 2007). This suggests that lack of light or exposure to light at times of day that we have not adapted to over thousands of years can have a significant effect on our health and is potentially very toxic over a long period of time.

Scientists have also discovered that the color of light that stimulates the circadian clock is slightly different than the color of light that is used for the visual system. The maximum visual sensitivity lies in the yellow-green region of the light spectrum, whereas the non-visual system perceives light that is shifted into the blue spectrum. Thus, blue light is more potent for stimulating physiological responses through the non-visual system. Human beings evolved with different colors of light shifting throughout the course of the day: the sky ranges in color from blue in the morning to red in the evening. Similar patterns are necessary for our non-visual response to light.

Skylights allowing daylight into patient recovery areas (Burpee, 2008)

For optimal health, the human eye would receive blue light during the day, warm light in the afternoon (without high intensity blue light), and red light or no light at night.

The amount of light that is necessary for human health is a research topic that is currently under investigation. Although dose response and daylight have not been fully quantified, the relationship between daylight and its positive effect on human health has been well documented. As Daniel Kripke, M.D. at UCSD points out in his research, most people, even in a very sunny climate, do not have enough access to natural light on a daily basis.

The discovery of a non-visual light responsive receptor that regulates physiological processes highlights the fact that light must be thoughtfully examined in the built environment. This point is even more critical in hospitals, institutions that are striving to heal. Research points out that the color of light, timing, and intensity are all critical aspects to maintaining a normal physiological response to cyclical light patterns. Several aspects specific to hospital design make these objectives more difficult, yet more critical. In hospitals, employees work long hours, traditionally in areas that receive little to no daylight. Additionally, it is necessary for hospitals to operate twenty-four hours per day, thus night shift workers exposure to light at night is a critical issue; their tasks must be performed with enough light for critical task efficiency, yet this may disturb their circadian cycle if these lights are too blue in color.

The most beneficial healing environment for patients would include as much daylight as possible during the day, reduction in the amount of blue light from electric light sources during the evening, and fully dark rooms at night. Additionally, research has shown that patients in rooms facing east heal faster and have lower incidences of depression (Joseph, 2006).

The biggest architectural implication for light and human health is designing a building that creates as much opportunity for accessing daylight as possible. Our non-visual system has evolved to respond to natural light, thus it is critical to provide spaces that work with the natural rhythms of the environment and allow occupants access to natural light. To achieve this relationship, the building form will be thinner and have more surface area, thus more opportunity for natural light. Spaces that have been traditionally thought of as 'dark' spaces can even have windows incorporated to include natural light. This thinner plan building can then be complemented with an electric lighting scheme that takes into account the importance of limiting the amount of blue light exposure at night, for both staff and patients. Maintaining control of electric lighting between rooms is also critical. For example, limiting the amount of light that 'leaks' from the corridor into the patient room at night. [In order to accomplish a thin plan and light in traditionally dark spaces, the distribution of the programmatic functions of the hospital may need to be reenvisioned.

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