INTERIOR LIGHTING IN THE ARCHITECTURE OF HEALTHCARE FACILITIES

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Summary

In this paper the authors would like to compare various types of lighting in different types of healthcare facilities and their interiors. Lighting in these types of facilities has several purposes - they can range from being a discrete and calming light in the waiting rooms, a monitoring light in the hospital rooms and orientation lights, to antibacterial UV lamps which sterilize the air and instrument surfaces with their radiation in the operating rooms. Various combinations of light are used in these interiors (direct, indirect, variations in the intensity of illumination and color temperature, just to name a few), which the architects combine with the color schemes of the interior in order to enable better functional and visual solutions.

Key words: hospital, lighting, intensity of illumination, operation theatre, intensive care unit, non-intensive care units

When designing public buildings, the architect adjusts his design, both in a functional and aesthetic sense, to suit various needs and tastes, as a consequence of the increasing numbers of employees and visitors in such facilities. This task becomes even more complex in the case of healthcare facilities. It is necessary to adjust the interconnection between a great number of rooms used for various purposes by horizontal connections which are meant to be as short as possible, as the distance could mean the difference between the life and death of the patients. The dimensions of each individual room need to be defined properly so that the necessary apparatus could be fitted inside it, with the possibility of the addition of new apparatus during the course of a year. This should, at the same time, enable the unhindered movement of the hospital staff. Last but not least, by adjusting the color scheme in the interiors and the lighting, an effect of comfort could be achieved, which, according to certain researchers, could have a therapeutic effect.

For various types of healthcare facilities, different rules have been posited in terms of lighting, be it general or local, and in terms of the intensity of illumination, which needs to enable the unhindered work of the doctors and hospital staff, but also a comfortable stay for the patients during the course of their therapy or rest. Adhering to these rules, the architect designs a new ambient and invests it with his own individual mark.

Lighting has a considerable effect on the appearance of a space. The visual appearance of the lit space also applies to the way lighting equipment integrates with the architectural design and the physical elements of the building. It is equally important to ensure that electric light integrates with daylight.[6] The use of color plays many roles in the interior design process for healthcare facilities. Colors can help the patients' orientation, if different colors are used for different wards. Monochromatic, bland color schemes and fashionable or trendy palettes or pastels should be avoided. Brighter colors may be preferred for patients with depression and some older adults, but they could be over stimulating for highly agitated patients. Warm blue tones often have a soothing or sedating effect, presumably because of their shorter wavelengths, and they may be particularly suitable for the calmest areas. Using closely related colors of the same value and intensity has also been reported to have a calming effect. Blue-green colors can have negative effects on the mood of patients with depression and less energy.[3] By using the appropriate colors in waiting rooms, examination rooms, hallways and hospital rooms, we can influence the subjective sense of comfort and the patients' stress levels. It
has been proven that natural lighting and the observation of nature can have a positive effect on the state of the patients, which is why the inclusion of windows is recommended in hospital rooms.

Windows are of key importance; as well as natural light, they provide an outlook, contact with the outside and access to sunlight about which patients are extremely positive. Windows should therefore be sized and positioned to provide a view out, regardless of location, as well as a reasonable average daylight factor. Good, controllable solar shading is essential. The colour and materials of window treatments such as blinds or curtains needs to be chosen with care to enhance the interiors or control glare[6].

NON-INTENSIVE CARE UNITS.
These units house patients whose state is not critical; therefore, during the course of their treatment, it is necessary to create the optimal conditions for their normal functioning. These patients usually have TV sets or phones in their rooms, which allows them contact with the outside world and makes their stay in the hospital room more bearable. Each bed requires a special reading light – direct light. It is usually aimed only at the bed above which it is placed so as to prevent any of the other patients in the neighboring beds from being disturbed. This type of light is positioned at a height of 1,8 m from the finished floor level. The recommended intensity is 200 lx.

In rooms which contain many beds, the problem of a glare could occur if the light above the hospital bed is exposed to the view of the other patients. The sharp contrast between the parts of the wall in the immediate vicinity of the light and the strong illumination coming from the edges of the light could cause discomfort at direct eye-contact. It is for this reason that general lighting in a hospital room is usually indirect lighting. The light source is positioned above the hospital bed and the light is aimed at the wall and ceiling, which enables the necessary even lighting above the hospital bed and eliminates the formation of shadows. The recommended intensity is 100 lx.

The lighting in rooms should enable good visibility for the uninterrupted examination of patients and the implementation of therapy (work light). Work light can be obtained if the indirect and direct lighting is turned on simultaneously.(Fig.1) That enables an intensity of illumination of 300 lx.

The recommended illumination of the space between beds and the aisles is 150 lx measured on the floor surface. This amount of illumination is enough for the performance of basic hospital activities, without any disturbance to the patients who may be at rest.

Monitoring light (night light) enables hospital staff to move about freely in the hospital room at night and to monitor the state of the patients. The level of the light must be sufficient to allow for the detection of any changes in the appearance or gestures of the patients, but low enough not to disturb the patient’s sleep. The recommended intensity is 5 lx in the area between the hospital beds, but it cannot exceed 0,5 lx above the headboards. Most lamps which are meant for hospital use offer a combination of direct, indirect and night light, with the possibility of using each of these individual types of lighting, as well as the oxygen supply and the use of various hospital apparatus.

Orientation light is meant to be used beside the front door, at 0,3 m from the finished floor surface. It clearly marks the entrance into the room, and at night, functions as a guiding light for those patients who leave their rooms. These lights are covered, for protective purposes, with metal grids painted in natural colors, which can easily be combined with various interiors. Some of the models are inserted into special slots allotted them in the walls, thus giving light both to the room and the entrance hallway. [2]

The walls in non-intensive care units are usually painted a light shade of blue, yellow or green.

Any technical demands regards lighting can be found in DIN 5035 section 3 („Interior artificial lighting – Recommendations for hospital lighting“):
INTENSIVE CARE UNITS. Patients suffering from a critical condition and whose life may potentially be threatened are usually housed in these types of units. They are often unconscious and are under the constant care and supervision of doctors and nurses. In these rooms the color of the walls does not play an important part, due to the condition that the patients find themselves in, and the only important thing is that the walls should not be white, due to the great reflection which is characteristic of this color. The windows are most often fixed so as to allow the air conditioning of the hospital sick rooms. [1]

The prescribed general lighting can also be found on the ceiling, and its intensity is 500 lx with the possibility of regulating its intensity to the minimum. The local work and routine medical examination light placed above the hospital bed should be at least 200 lx.(Fig.2) An additional intervention light – a moveable light, is placed above each individual hospital bed and gives the doctor intense light during emergency procedures. It is focused on the required part of the patient’s body and needs to be at least 300 lx. [1]

The night light is the same as in non-intensive care units.

A special room which is visually connected by means of transparent barriers with the intensive care units is the nurses’ room. The general lighting in this room is 300 lx and is the obligatory additional light above the writing table. It is necessary to enable visual contact with each of the patients, which is why the floor in this room is raised by 20-30 cm in comparison to the floors in the patients’ rooms.

OPERATION BLOCK. The operating room covers a surface of 45 to 50 m² often even more.[2] The room has to be without any visual obstacles, functional and comfortable for the doctors and staff who work there. The color white is not used in operating rooms due to great reflection. “The color painted onto the walls and ceiling in operating rooms and in intensive care units is green-blue, according to RAL 6011. The walls are painted special colors which have antibacterial effects in coatings greater than 50 microns.” [2] The wall coatings, due to the need for a high degree of hygiene and sterility, are applied in a material which is inert, waterproof and fire retardant. This material must not contain even the slightest amount of radioactivity. The material used to coat operating theatres must be sturdy enough to withstand frequent washing. [8] The floor and ceiling in the halls must be made of antistatic material, without any signs of two surfaces being joined together, monolithic, made from water and fire proof material. The minimal height of the ceiling is 3.00 m due to the height at which the operating lamp and ceiling columns of the surgeon and anesthesiologist are placed.

The basic requirement that lighting in the operating room needs to satisfy is to provide a sufficient amount of light for examinations, patient treatment and operations. It is important that the light have color rendering characteristics i.e. CRI≥90.

General lighting with an intensity of 500 lx is enabled by lighting fixtures and used for work within the operating room, both when there are no operations in progress (the regular cleaning and preparation of the operating room) and during operations. These lights are meant to provide enough light in the operating room in order to avoid any great contrast in the illumination of the bed on which the operation is taking place and the remainder of the theatre.(Fig.3)
Local lighting – in order to illuminate places where operations are being performed, operation lamps are placed on the ceiling or wall, which usually have an intensity of 2500-5000 lx, and include reflectors, constructed in such a way as to offer light without shadow. The position of these lamps can be regulated.

Bactericide lights are used to sterilize the air and instrument surfaces by means of UV rays. They are primarily used in healthcare facilities (operating rooms, intensive care units, delivery rooms, just to name a few) but are also used in rooms where a great many people come together or rooms where products are processed (waiting rooms, pharmacies, kitchens and the like).

Fluorescent tubes are used as the source of radiation (low pressure mercury bulbs), which emit a characteristic ultraviolet (UV) radiation with an optimal bactericide effect at 253.7 nm. Since great exposure to UV rays can cause unwanted effects (Conjuctivitis, Erythem) it is necessary to adhere to the standards determined by the American Medical Association.

In cases where the staff spend prolonged periods of time in zones of UV radiation, where the intensity of the radiation is greater than the recommended one, it is necessary to use protective cream and glasses.

THE WAITING ROOM. In the waiting rooms and doctors’ offices, it is necessary to create an intimate atmosphere for the doctor and the patient’s family members, one which would instill them with a sense of trust of the hospital staff’s competence, and which would help the users of the facility to feel more comfortable at difficult times. The general lighting is indirect and has an intensity of 200 lx. The lighting should be well-diffused and free from a distracting glare or harsh contrasts. The colors of the wall should be light colors and warm hues.

THE RECEPTION DESK. The reception desk is what the patients, with life-threatening conditions, and their families first come into contact with when entering the hospital. The efficiency of the reception desk workers and the speedy processing of the patients, but also the appearance of the desk and the rooms which surround it, offer the patient his first pieces of information regarding the competence of the staff in that healthcare facility. The choice of proper color and proper lighting can influence the workers themselves and affect their productivity, by making them feel comfortable while working in a harmoniously decorated ambient. These rooms are usually large open plan areas and the walls are at a distance which cannot be used in such a way as to contribute to the visual impression. The huge ceiling is what dominates this area and it is lit with the help of direct/indirect luminaire systems. When using a pattern according to which the lights are positioned, the problem of a glare could occur if the difference between the lit and unlit part of the ceiling is too great. For this reason, the "Balanced Lighting" system is recommended in this case. This means the use of a relatively uniform pattern, in which case the relation between the best-lit part of the ceiling and the average value of the illumination will be 3:1 at most.[5] Furthermore, sudden transitions should not be made in the amount of light if a surface with high reflection is used. Instead, the transition should be gradual. By means of indirect lighting on the vertical surfaces of the desk, individual architectural details could be accented and an appealing visual effect created.

HALL LIGHTING. The basis of a hospital is great and complex, and the system of hallways within it, which connects all of the inner zones, irrespective of how well it may have been designed, may appear to be confusing to the person who sees the hospital for the first time. The use of well-lit signs is compulsory, as, if well planned, they guide the user and offer the first visual information. The lighting in the hall not only enables visibility but acts as a guide as well. The organization of work in the hospital to a great extent depends on well-designed hallways.(Fig.4)

The predicted intensity of illumination is 150 lx at the floor level.
When designing the network of hallways, it is very important to take into consideration the patients who will use these hallways or will be transported along them. Thus, the architect should use a lighting pattern which will not cause a glare by means of alternating parts with a high and low degree of illumination, and thus cause the seriously ill patients discomfort. These lights should be able to work at 50% of their capacity, which would be the case at night or during periods of reduced patient frequency.[5] This will enable the hospital to save energy.

**EMERGENCY LIGHTING.** The emergency lighting for patient evacuation is meant to help the hospital staff during the safe removal of patients and visitors to safe locations and to enable complete evacuation if necessary. The intensity of illumination should be at least 1 lx along the central line of the hallway with a width of 2 m, in other enough to enable and facilitate horizontal movement especially in zones where elderly patients can be found. The designed points of gathering in a time of crisis and the final destinations would be lit by a minimum of 5 lx in order to stand out in relation to the remainder of the hallway.

The eye as an organ is not only used for looking, for by means of photoreceptors and nerves, it conveys information to the brain and in that way participates in and controls many of the processes in the body. By means of different perceptions of light, the daily rhythm of various processes in the body is regulated.

The chart (Fig.5) shows the significant information for lighting design in healthcare facilities. By observing the curves we can note that the maximum visual sensitivity of the eye is in the yellow-green part of the specter and the maximum biological sensitivity is in the blue shades. The new models of lights which are used in hospitals have precisely that color temperature which suits blue hues.

If we were to look at the processes that take place in the body,(Fig.6) which are tied to changes in bodily temperature, the secretion of the hormone melatonin and cortisol and the vigilance state during a natural twenty-four hour cycle, they indicate that the level of melatonin drops and the level of cortisol increases during the day, while at night the situation is reversed. When a person is ill, or works night and day, suffers jet lag or the like, this cycle is disturbed, which leads to fatigue, insomnia and confusion.

The synchronization of these cycles can be achieved by an artificial control of the intensity of illumination and the color temperature, simulating daylight, which may help improve the overall health of the patients.

The development of technology in the field of light manufacture is an indication of the fact that, in the near future, lighting will play an important part not only in the creation of visual impressions, but will also be an active participant in the treatment of the patient.
REFERENCES


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