Nursing and Health 1(2): 21-30, 2013
DOI: 10.13189/nh.2013.010202 http://www.hrpub.org

An Architectural Study on the Relationship of Skylight and Patient's Satisfaction at the Ambulatory day careward in Agha Khan Hospital Pakistan

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Abstract The purpose of this study is to identify the determinants by which sun light increases the effectiveness of human health and performance and review the literature associating daylight with health outcomes in Pakistan healthcare settings. A skylight may provide variable degree of comfort for hospital buildings as that of high energy expenditure hospitals. Skylight is physical aspects in hospital design which devices a healing environment. This paper validates the role of daylight on patient's relief. Methods include determinants of day light design identification in the basement plan of six bedded nightingale ward which is a case study for this research. For verification a field survey was conducted along with designed questionnaires which were filled by patients upon request along with nurses and visiting families. This study is based on the Ulrich [9-13] proposal that: a view of natural elements serves to evoke positive emotions and governs trauma.

Keywords Day Light, Sky Light, Ultra Violet UV Radiation Calculation

1. Introduction

On one hand Pakistan is facing severe energy crises, and on the other the planet is going through global warming. This has resulted in growing health issues, the only solution for both is low carbon planning. The purpose of this research is to show the effects of the windows of AKU hospital design. Moreover, to calculate the amount of UV light if it is sufficient for mood satisfaction. This research has taken into account analysis of ecological hospital designed with considerations of sun light. The mass of the building is built in a form to have the exact angle every hour for sufficient UV rays from the window. The efficiency with consideration to the mood satisfaction at AKU has been examined in regard with window design and UV rays.

Literature suggests that adequate exposure to natural light provides a positive impact on human health and well being of patient and medical staff in a hospital environment. At AKU Hospital the day care skylight is functioning as an ecological as well as healing for surgery daycare ward. In a daycare all activities are conducted all day long, hence little electricity lighting is used here, most of the natural full spectrum light is provided from the sky light. AKU is designed to give patients, visitors and staff contact with nature this may be a matter of physical access. Views of nature are known to be therapeutic. Gardens in healthcare environments are calming in themselves. Views from Skylight have mechanisms such as fostering access to social support and providing opportunities for positive escape and sense of control with respect to stressful clinical settings [9-13]. A peaceful nature scene is superlative in inducing feelings of calmness and safety [9-13].

1.1. Research Statement / Hypothesis

The statement below best describes this paper: "A skylight design can provide same or even more (i.e. variable degree) level of comfort (vitamin E) for hospital buildings as that of high energy consumption hospitals". Relevance to Design Practice – The main objectives of this research is to calculate the radiation penetration through, the skylight design of the east wall of Agha Khan Hospital Karachi, and to analyses if it sufficient for the vitamin E.

The discussion below explicitly reveals the methodology used for this research. It can be summarized as:

1.)Taking the existing skylight plan of a typical ambulatory ward at AKU (Agha Khan University Hospital) and then calculate the sun energy entering from the window and its impact on healing in terms of Vitamin E production, by analyzing the answers from the patients.

2.)Calculating and comparing the effects on patients healing, through radiation penetration from fenestrations

1.1.1. Background and Objective

In recent times and in coming future, patients will chose hospitals and healthcare settings not only for best clinical services available, but rather for those that best satisfy their expectations for mood satisfaction and healing environments in which safety, dignity and personal comfort are key variables.

It is well established internationally that the recovery of patients in hospitals and healthcare settings is affected by their experience of the environment that surrounds them. The aim of this paper is to observe patient's satisfaction according to the evidence based design, since hospital promotes healing and mood satisfaction. The classical element on health benefits applied here is day light. The replies from the questionnaire suggested that surgical wards without day light for diagnostics and curing have contributed in stress, depression, and anxiety. Staff members and visitor's included, terms such as confusion, dull, shabby, for the window less area. Spaces with artificial glare with little natural light, were termed as isolation physical restraints by the staff for the basement wards without skylight design.

2. Materials and Methods

A three month quasi experiment was conducted, on site by author after survey. The patients at day care center were invited to participate in a questionnaire regarding the aesthetics of the day care space in relationship to the healing, and well- being amongst the patients. The study was approved by the Agha Khan University (AKU) hospital's Public Relations Committee for Medical and Healthcare Research Ethics and the privacy ombudsman for the research at the Agha Khan Hospital Data Service for facilitating the data collection. More than hundred answers have been analyzed statistically. Results indicate crucial findings are the quantitative observation and opinion compared with numerical data of luminance of daylight in the ward environment with regard to satisfaction and vision comfort. For social and symbolic healing luminous ambiance is a vital aspect for hospital healing environment. Implications includes preceding scientific studies by Ulrich have tested that surgery patients having sight to nature in ward spent less time in hospital. Since AKU nursing administration registered 3.4 days of hospitalization as an average for 2012. This is intended to be reduced to 3 days by 2013. Recently the surgical day care ward is designed to release the patient same day after surgery.

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2.1. Theoretical Study

The psychological behavioral effects of natural light, on humans have been investigated in the fields of mood satisfaction. Human biology and psychology [13] studies indicate that: neuron hormonal mechanisms regulated by the appropriate environmental lighting can cause in elevated mood, alertness, and arousal, resulting an increased productivity and efficiency and reduced cognitive impairment and sleepiness. However, limited studies have carried out on the effect of daylight, and the presence of windows on healthcare employees' health and performance, for Asian countries, specially Pakistan (Table 1).

It is normally believed that closely controlled conditions equate with better comfort. Analysis of field surveys and adaptive comfort theories have made it clear that while closely controlled is one way of achieving comfort it is not the only way. The healthcare architects can best utilize the sunlight by minimizing the radiation effects. It is the ultra violent radiant energy emitted by sun as a result of its nuclear fusion reactions.

Most healthcare settings, as well as other buildings, are lit by a combination of daylight entering through windows and skylights and electric-light sources. It is important to understand how these two types of light sources differ to understand their relative impacts on human health and performance. Sunlight is electromagnetic radiation in the wavelength range that can be absorbed by the photo receptors of the eye. Sunlight provides a balanced spectrum of colors with elements in all parts of the visible wavelength range [7]. The actual wavelengths present in daylight vary over the day with latitude, meteorological conditions, and seasons [5].

One of the well-known beneficial photochemical process that occur this way in the body is the metabolism of vitamin D. Research shows that most of the vitamin D in the blood can only be derived by exposure to light [6]. The UV radiation in the daylight is considered to be important for this process to occur. Most people are able to metabolize vitamin D by exposure to light.

2.1.1. Previous Studies Review: Correlation with Independent terminologies

The other objectives achieved here from the questionnaire were the following terms, and there explanation by the patients, staff and visitors.

1). Image, the visual concept of the building refers to and the ways of the building attracting attention to itself. The form of the building and the symbolic attributes

2). Community refers to how the building and its site represents a better hospital neighborhood and identity in terms of safety, security, and privacy.

3). Efficient functionality is an attribute in which the building is able to respond to the work which is held in process in it; and flow of people, equipment, and material.

4). Security here is defined as the level to which the building can segregate sensitive functions from one another and prevent the entry of people to restricted areas.

5). Flexibility is defined as the degree to which the building plan can be rearranged to conform to revised work progress and personnel changes.

7). Technical Performance refers to how the building operated in terms of mechanical systems, electrical systems and industrial processes.

8). Human performance is defined as how the building provides a physically and psychologically comfort to the residence, to work and live.

This paper shows another way of attaining comfort levels i.e. by constructing better windows and skylights for hospitals of Karachi. While the complex incorporates state-of-the-art educational and medical technologies, it also demonstrates that a modern architectural solution should preserve the spirit of its culture.

2.2. Impact of Sun Light on Human Health and Performance

Finally there is a discussion on a model hospital window, considered as an Eco-Hospital window designed to take the advantage of green landscapes for obtaining the varying degree comfort levels as with the controlled methods. Research explores the role of design in improving the quality of patient environments to support the healing process and stimulate wellbeing. Questionnaire studies showed that bedridden patients assign especially high preference to having a hospital window view of nature [9].

Sun Light impacts human health and performance by two main mechanisms:

1. Controlling the body's circadian system
2. Affecting mood and alertness

In this section of paper, above two mechanisms is described and the specific impacts on human health and performance are outlined.

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A recent randomized prospective study assessed whether the amount of sunlight in a hospital room modifies a patient's psycho-social health, quantity of analgesic medication used, and pain medication cost [14]. Patients undergoing elective cervical and lumbar spinal surgeries were admitted to the bright or the dim side of the same hospital unit postoperatively. The outcomes measured included the standard morphine equivalent of all ovoid medication used postoperatively by patients and their subsequent pharmacy cost. Patients staying on the bright side of the hospital unit were exposed to 46% higher-intensity sunlight on average. This study found that patients exposed to an increased intensity of sunlight experienced less perceived stress, marginally less pain, took 22% less analgesic medication per hour, and had 21% less pain medication costs [14].

3. Comprehensive Evaluation

The warm summers in Karachi coupled with the intense high-altitude sunshine make passive solar control of skylight one of the important design considerations.

The uncontrolled solar gain results in high cooling loads and excessive illumination, and also increases glare. The first strategy in sunlight and radiation passive cooling is solar heat gain avoidance, which can be achieved primarily through shading and selection of appropriate glazing devices e.g. Mashrabiya and Brise soleil.

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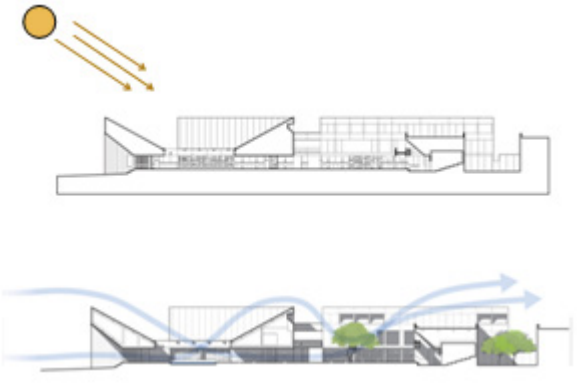
Figure 1. The patient with the waiting accompanying for recovery under the sun, after anesthesia, for eye operation, on 3rd March 2013, 11:30 PM. As shown in the Table. 1. The section shows the detail of the skylight, where the picture is taken

3.1.1. Analysis on Preferences light

The sun also creates few problems for living beings. For example, extreme heat which is often undesirable for it causes an increase in temperature. Therefore people have found ways over time to use the power of sun and reduce its negative effects. Nevertheless, the architects have also played role in maneuvering this source intelligently. When this ultra violet radiation is not absorbed by the atmosphere or other protective coating, it can cause adverse effects for humans in general and the overall climate in particular.

Design of the site section where some buildings faces direct light from sun. Providing exposure to nature and other positive distractions to calm patients, reduce stress and pain.



Source: http://www.payette.com (used with permission of Payette)

Figure 2. Section of the Agha Khan typical ward area

3.1.1. Analysis of High-Performance Features and Systems:

AKU is an Eco-Hospital with an energy efficient skylight which uses the surrounding natural resources to heat, cool, and views. This research highlights the importance of the ecological skylight architecture, to optimize comfort, and views [3]. After the questionnaire had been analyzed from (Table.1) it was clear that a space with natural light were highly preferred and resulted into the mood satisfaction of the patients, and other users. The second part of this research focuses on one hand: how to design such spaces which maximizes the exposure to sun. On the other hand it provides shading device to control the over whelming sun at certain hours of time.

3.1.2. Concept of Mashrabiya and Brise soleil.

At AKU Mashrabiya concept is used to soften the rays of sun. It is the Arabic term given to a type of projecting oriel window enclosed with carved wood latticework. (Mashrabiyas were mostly used in houses, public buildings such as hospitals, inns, schools and government buildings).

AKU uses Brise soleil design to maximize the use of UV rays along with softening the radiation. Brise soleil, sometimes brise-soleil (breez-soh-ley, from French, "sun breaker"), in architecture refers to a variety of permanent sun-shading techniques, ranging from the simple patterned concrete walls popularized by Le Corbusier.

Figure 3. a,b,c,d,e, clockwise. The use of windows, Mashrabiya gate
3b: The courtyard to invite nature in the interior spaces
3c: The corridors looking on to the courtyard and fulfilling the accessibility criteria, providing a healing environment
3d: Corridor Brise soleil connect to the exterior space, a passive architecture approach.
3e: spacious ICU design comfortable for the staff, family and patients
The above windows design picture, used after the permission of AKU. (The approval was granted by the privacy ombudsman for the research at AKU public affairs department)

3.2. Analysis of the Questions Regarding the Satisfaction Regarding Healthcare Environments

The most important question arise here is "What do

patients (and employees) need to see from the window" and 1) "Which architectural and atmospheric elements viewed from the window are perceived to enhance wellbeing and satisfaction"?

2). Secondly concerning the Healing Environments that should be more than 'just' designing a proper environment that reduces hospitalization duration or asking questions e. g. Can the views from Window reduce the hospitalization time.

3). Focusing on smooth care delivery processes (window and views production orientation)

4). Proposing a design for future: a more pleasant hospital window than present available.

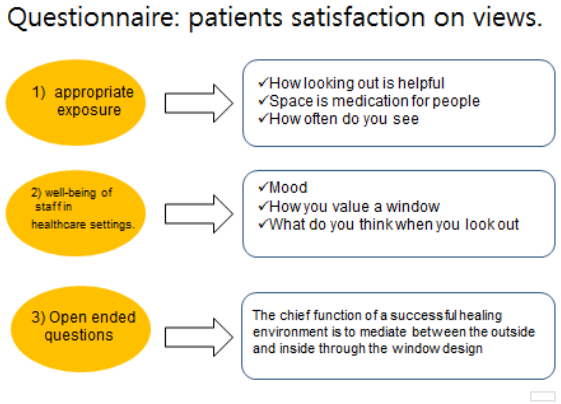


Figure 4. The presented of model questions from the questionnaire

3.2.1. Analysis of the questionnaire from Nurse

1). How do people classify window views in terms of their health status?

2). What is to be understood and treated about the windows?

3). The experience varies on the basic of a scientific diagnosis of the surgical disease of the patient vs. assessment of the overall state of health/illness of persons

4). How is suffering to be treated?

The search for the answer to the question "What explains movement toward the health: end of the health/illness?" led to the study of windows and views resources. Such resources are conceptualized in terms of the overall construct of the sense of orientation and meaningfulness.

The better view, breath and heart beat through views is clearly not a particular coping strategy, but a general orientation to life.

The hypothesis proposed is that the stronger the views

from windows, the greater the likelihood of moving toward the healthy hospitals (Figure. 4) Questions regarding the sun light compared to electric lighting were asked. Finally, calculating and comparing the effects on patients healing while calculating UV rays from windows.

Unless it is properly calculated, it would be difficult to minimize the radiation. For the purposes of this paper, the calculations on the longest day of the year i.e. June 22nd were made (Table. 2). These calculations were subject to the orientations of the building. The formula can be used for radiation calculations as shown in (Table . 2 and 3).

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Unless it is properly calculated, it would be difficult to minimize the radiation. For the purposes of this paper, the calculations for the east wall on the longest day of the year i.e. June 22nd (table. 2) as well as the shortest day that is 22nd December (table. 3) were made (Table2). These calculations were subject to the orientations of the building.

Table 1. The table above was built up from the questionnaire

type of users	no	age	electricity lighting	sky light
Children	20	5-10	confusion	recovery appreciably greater
Male patients	20	70	dull	balanced spectrum of light
Female patients	10	65	fear	pleasantness and calmness
Nurse	10	30	sleepiness	wake fully relaxed
Male visitor	20	45	anger	restoration to positive change with in five minutes
Female visitor	20	45	sadness	emotional and self report converged
Total	100			

3.2.2. Quantitative Evaluation Indicators: Solar Constant

As we all know that Sun is the brightest star in the solar system. It gives us light which is a valuable source of heat energy.

It can be considered as the 'life blood' for all living things on the planet and without which, almost all the living organisms would fail to exist.

The Solar constant is the amount of the Sun's incoming ultra violet radiation per unit area, measured on the outer surface of earth's atmosphere. It includes all types of solar radiations, not just the visible light.

The (Figure. 5) is used for calculations in formulas used in (Table 2) where the UV light entering the space is measured.

The following value is added in all the calculation of radiations for final columns of all readings in (Table 2&3).

$$I_{\circ} = 1353 \text{ watts /sq meters} \quad (1)$$

Equation 1 shows $I_{\circ}$ = intensity of the outer surface of the earth 'solar constant'. Although $I_{\circ}$ is never constant, and it varies with the different environment conditions. But we always take an average which is solar constant as shown above. The formula can be used for radiation calculations as shown in (Table 2 & 3).

Table 2. Readings from east window on 21st June which is the longest day and comparison with the 21st December which is the shortest day (any given year). Review of sun from 22 feet by 5 feet skylight, which is equal to 37 square meters though the mashrabiya is subtracted which gives 18 square meters, hence the area is calculated according to the present conditions and requirements.

		Readings on 21st JUNE									
Elevation (orientation)	Glazed Area (m2)	Timings	Wall Azimuth (degrees)°	Altitude (angle degree) °	Solar Azimuth (angle) °	Wall Solar Azimuth °	Angle of Incidence °	Direct Rad. 850 W/m2	Direct Rad. through Window Watts permeter2	Diffused Rad. 350 W/m2	Total Radiation Watt per meter square
East	2	6:00 AM	90	13	70	20.00	0.92	778.27	1167.40	525.00	1692.40
	2	7:00 AM	90	25	77	13.00	0.88	750.62	1125.93	525.00	1650.93
	2	8:00 AM	90	39	85	5.00	0.77	658.06	987.09	525.00	1512.09
	2	9:00 AM	90	51	90	0.00	0.63	534.92	802.38	525.00	1327.38
	2	10:00 AM	90	63	101	11.00	0.45	378.80	568.20	525.00	1093.20
	2	11:00 AM	90	75	120	30.00	0.22	190.52	285.78	525.00	810.78
	2	12:00 PM	90	82	180	90.00	0.00	0.00	0.00	525.00	525.00
	2	1:00 PM	90	75	240	90.00	0.00	0.00	0.00	525.00	525.00
	2	2:00 PM	90	63	259	90.00	0.00	0.00	0.00	525.00	525.00
	2	3:00 PM	90	51	270	90.00	0.00	0.00	0.00	525.00	525.00
	2	4:00 PM	90	39	275	90.00	0.00	0.00	0.00	525.00	525.00
	2	5:00 PM	90	25	283	90.00	0.00	0.00	0.00	525.00	525.00
	2	6:00 PM	90	13	290	90.00	0.00	0.00	0.00	525.00	525.00
									4936.79	6825.00	11761.79

Table 3. Readings from east window on 21st December the shortest day (any year)

		Readings on 21st December									
Elevation (orientation)	Glazed Area (m2)	Time	Wall Azimuth°	Altitude angle °	Solar Azimuth (angle) °	Wall Solar Azimuth °	Angle of Incidence °	Direct Rad. 850 W/m2	Direct Rad. through Window Watts	Diffused Rad. 350 W/m2	Total Radiation Watt per meter square
East	2	6:00 AM	90	0	110	20.00	0.94	798.74	1198.11	525.00	1723.11
	2	7:00 AM	90	1	117	27.00	0.89	757.24	1135.86	525.00	1660.86
	2	8:00 AM	90	14	130	40.00	0.74	631.80	947.69	525.00	1472.69
	2	9:00 AM	90	22	140	50.00	0.60	506.58	759.88	525.00	1284.88
	2	10:00 AM	90	27	149	59.00	0.46	390.07	585.10	525.00	1110.10
	2	11:00 AM	90	31	163	73.00	0.25	213.02	319.53	525.00	844.53
	2	12:00 PM	90	33	180	90.00	0.00	0.00	0.00	525.00	525.00
	2	1:00 PM	90	31	195	90.00	0.00	0.00	0.00	525.00	525.00
	2	2:00 PM	90	27	210	90.00	0.00	0.00	0.00	525.00	525.00
	2	3:00 PM	90	22	220	90.00	0.00	0.00	0.00	525.00	525.00
	2	4:00 PM	90	14	230	90.00	0.00	0.00	0.00	525.00	525.00
	2	5:00 PM	90	1	240	90.00	0.00	0.00	0.00	525.00	525.00
	2	6:00 PM	90	0	250	90.00	0.00	0.00	0.00	525.00	525.00
									4946.17	6825.00	11771.17

4. Grouping of Facilities on ECOTECT

At the third stage of this study we have taken into account case studies of the shading devices of the eastern skylight of the AKU hospital.

These are designed and adjusted according to the angle of the sun; both annually as well as daily basis. Analysis is conducted on the environmental performance of buildings on the software named ECOTECT. The basic function of the software is to analysis different variables namely, solar lighting. Also it conducts the thermal simulations on the models of the buildings as shown in (figure 3)

$$\text{Cos}(\theta) = \text{Cos}(A) \times \text{Cos}(WSA) \quad (2)$$

Where,

A = Angle of Altitude and

WSA = Wall Solar Azimuth (3)

For maximum radiation:

A = 90° (For East Orientation)

WSA = 90° (For East Orientation)

Altitude is the angular distance above the horizon measured perpendicularly to the horizon. It has a maximum value of 90° at the zenith, which is the point overhead. Azimuth the angular (equation 2 and 3) distance measured along the horizon in a clockwise direction. The number of degrees along the horizon corresponds to the compass direction.

Azimuth starts from exactly north, at 0 degrees, and increases clockwise. The angular positions for different degrees of radiation can be given as shown in above formula.

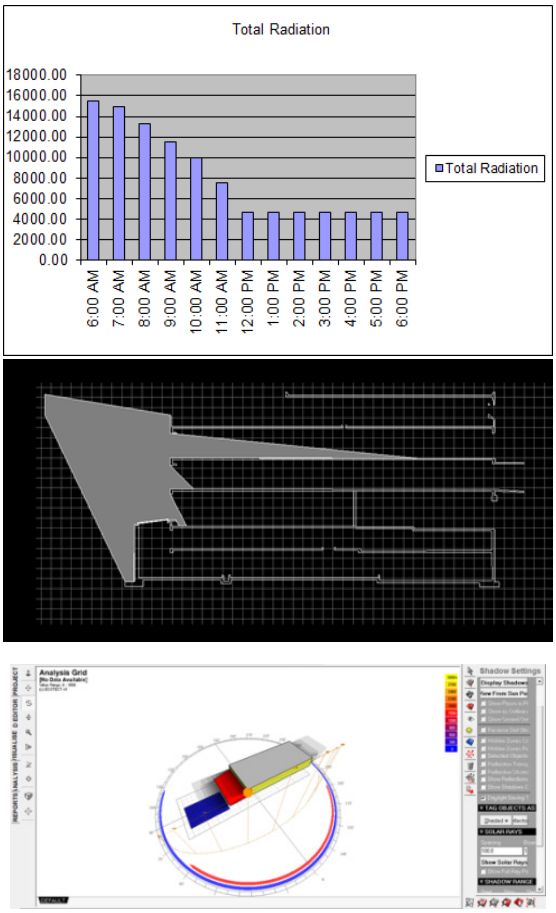

Figure 5. analysis on ECOTECT

4.1. Applied Analysis on Ambulatory ward: Thermal Analysis

There are a number of approaches for zoning that can be applied to Hospital building when performing thermal analysis these are,

Firstly, a thermal zone represents an enclosed space within which the air is free to flow around and whose thermal conditions are relatively consistent. In most cases, any room that can be closed off with a door would be a separate zone.

Sometimes temperatures in different parts of large spaces can vary. In these cases, the space can be divided into a number of smaller zones with adjoining elements defined as voids. This way heat is free to flow between the zones, but their thermal characteristics can be analysed individually.

Also, adjacent utility spaces such as store rooms, toilets and corridors can often be grouped together into the one zone. This is because the exact temperature of each utility space is seldom of interest, but their action as a thermal buffer between other zones may be important.

In (Figure4) ECOTECT is used for shading and lighting calculations, the division of zones is not as important and they can be used as layers to separate objects and functions. However, thermal and acoustic calculations require very specific zoning based on the above rules. The building is assumed to be unoccupied and there is no air-conditioning system in operation at this time of analysis.

4. 1.1. Thermal Analysis on ECOTECT Model

A model created for thermal analysis is geometrically simplified since the relevant attributes here are the thermo-physical properties; such as U-values and thermal admittance values. In the Computer Program ECOTECT if model of the building for the thermal calculation then it is also important to decide how to divide the building into appropriate zones, as shown in figure two a.

Since the objective here is to identify the mechanisms by which sun light impacts human health and performance and review the literature linking daylight with health outcomes in Pakistan healthcare settings. Hence in figure two The 3D Model structure is initially created in AutoCAD from measurements of the building. The user of the Ecotect has to be careful during the creation of layers for different elements of the building; such as walls, roofs, balconies, windows, and doors; for the layers creation might manipulate different features when exported to Ecotect, as shows in (Figure4).

Nevertheless, the model exported from AutoCAD is manipulated in Ecotect so as to assign the different elements their respective characteristics and properties. The type of modelling used has to be compatible with the analysis performed. For example, solar shading and lighting analysis requires a model that contains all the necessary geometric information whereas a different type of model is needed for thermal simulations, as shown in (Figure 5).

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At the third stage of this study we have taken into account case studies of the shading devices of the eastern skylight of the AKU hospital. These are designed and adjusted according to the angle of the sun; both annually as well as daily basis. Analysis is conducted on the environmental performance of buildings on the software named ECOTECT. The basic function of the software is to analysis different variables namely, solar lighting. Also it conducts the thermal simulations on the models of the buildings as shown in (figure 5)

4.3. Vitamin Implications

There is Evidence Based Design (EBD is the deliberate attempt to base the building typological decisions on the Best Available Evidence with a universal design achieving the best possible outcomes for the surgery day rehabilitation space1) that light is critical to human functioning and can be extremely beneficial to patients as well as staff in healthcare settings. Adequate lighting conditions are essential for performance of visual tasks by staff in hospitals, and poor lighting conditions can result in errors.

[1] Definition of 'Evidence-Based Design (EBD)' (Roger Ulrich)

In this regard is that lighting levels preferred by people are significantly higher than "today's indoor lighting standards and correspond to levels where biological stimulation can occur" [2]. They suggest that "biological lighting needs of humans are different from visual lighting needs, and lack of adequate light for provisions for controlling biological stimulation can lead to health and performance glare and temperature".

Sunlight Exposure (full body exposure)* 3,000 – 20,000 IU

Salmon (3.5 oz. of fresh, wild salmon)	600 – 1,000 IU
Salmon (3.5 oz. of fresh, farmed salmon)	100 – 250 IU
Fortified Whole Milk, 8-oz. glass**	100 IU
Fortified Multi-vitamin	400 IU

Source: [8]

* Sun exposure to the arms and legs for 10-15 minutes. Th amount of vitamin D produced depends on the intensity of the UVB in the sun and many other factors. Darker-skinned individuals may need 5-10 times more exposure than a fair-skinned person to make the same amount of vitamin D. In northern climates sunlight is too weak in parts of the year to make any vitamin D – a period referred to as 'Vitamin D Winter'.

** Vitamin D is supplemented into milk. It doesn't occur naturally in milk.

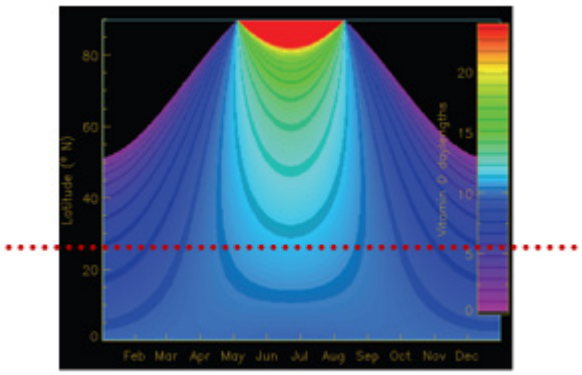

Figure 6. The horizontal scale shows the month, and the curve represents the about of hours. The latitude for Karachi is 24°53'N shown in red line

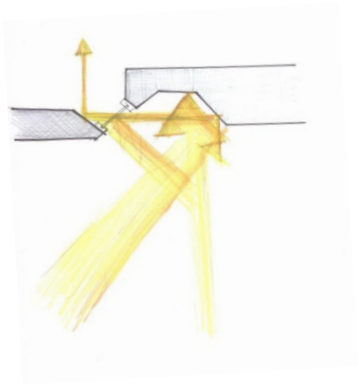

Figure 7. the window design one feet by 3 feet.

The above chart represents the amount of sun required for the Vitamin production. Hence the about chart shows latitude with respect to the country and the location on the globe, Karachi is located at 24.5 latitude hence, it require 1.6 hours of direct sun light radiation for the production of sufficient Vitamin E.

4.4. Analysis Target and Reliability verification

In the above picture the ration penetration from the east window of Agha Khan is analysed, The East side window design shows the angle at which the sun light penetrates to let in the sun light which is two hours of exposure on 21st June.

The main Objective was to identify the mechanisms by which sun light impacts human health and performance and review the literature linking daylight with health outcomes in Pakistan healthcare settings.

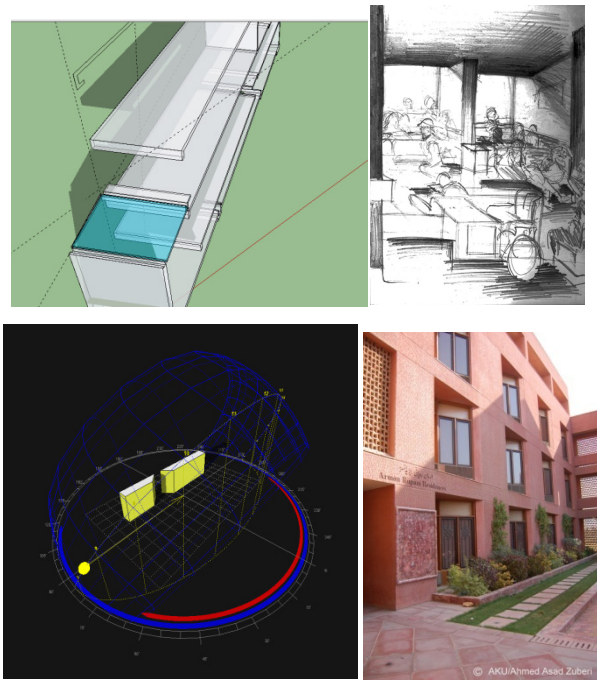

Figure 8a: Ecotect stimulation for the angled window design, Patient Environments Design Background and Objectives

Figure 8b: AKU web bank picture showing the patient and staff alertness level and the sun light through a window

Figure 8c: The window design picture, used after the permission of AKU. (The approval was granted by the privacy ombudsman for the research at AKU public affairs department) Incharge: Dhunmai Cowasjee AKU

5. Conclusion

The data is collected by conducting an in-depth interview, with a set of patients at the AKU hospital, regarding the healing acceleration. Results from the surveys with nurses about patient accelerated healing through the presence of windows and skylight; and the replies for betterment in sleep and mood satisfaction are then compared with quantity of satisfactory UV light. Conclusively, it was found that for the shortest day readings on 21st December which was mood satisfying was recorded to be 11,771.17 total amount of Radiation Watt per meter square.

Furthermore it was also found that the readings on 21st June were 11761.79 Radiation Watt per meter square. This amount of UV light is adequate to have the required amount of Vitamin D in the indoor environment.

The following conclusions were observed from the questionnaire.

Adequate and appropriate exposure to light is critical for health and well-being of patients as well as staff in healthcare settings.

Natural light should be incorporated into lighting design in healthcare settings, not only because it is beneficial to patients and staff, but also because it is light delivered at no cost and in a form that most people prefer.

Avoid building plans with large proportion of windowless rooms.

Suitable building orientation to provide access to natural lighting to improve patient and staff healthier outcomes.

Acknowledgements

The permission is been secured from AKU public Relation office and drawing have been provided by Payette Boston. Room assistance were administered by the secretary at the day care centre to secure permission to use images of the AKU interior of the day care ward

REFERENCES

[1] 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.

[2] Begemann, S. H. A, van den Beld, G. J, & Tenner, A. D, 1997, Daylight, artificial light and people in an office environment: Overview of visual and biological responses. International Journal of Industrial Ergonomics, 20(3), 231–239.

[3] 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.

[4] Blackburn, S, &Patteson, D, Effects of cycled light on activity state and cardio respiratory function in preterm infants. Journal of Perinatal & Neonatal Nursing, 4(4), 47–54, 1991.

[5] Boyce, P, Hunter, C, &Howlett, O. 2003. The benefits of daylight through windows. Troy, NY: Rensselaer Polytechnic Institute.

[6] Buchanan, T. L, Barker, K. N, Gibson, J. T, Jiang, B. C, & Pearson, R. E. illumination and errors in dispensing. American Journal of Hospital Pharmacy, 48(10), 2137–2145, 1991.

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

[8] Holick, M.F. Vitamin D Deficiency. New England Journal of Medicine, 357:266-281, 2007.

[9] Ulrich, R. S, Zimring, C, Joseph, A, Quan, X, &Choudhary, R. The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. Concord, CA: The Center for Health Design. 2004.

[10] Ulrich, R. S. Health Benefits of Gardens in Hospitals, Center for Health Systems and Design, 2002.

[11] Ulrich, R. S. Effects of Healthcare Environmental Design on Medical Outcomes, 2000. Online available from, http://treebenefits.terrasummit.com/Documents/Health/Effects%20of%20Healthcare%20environments.pdf

[12] Ulrich, R. S. 1986, Effects of Interior Design on Wellness - Major Hospital Foundation Online available from, http://www.majorhospitalfoundation.org/pdfs/Effects%20of%20Interior%20Design%20on%20Wellness.pdf

[13] Ulrich, R. S. View through a window may influence recovery from surgery. American Association for the Advancement of Science, 1984. Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D. The effect of sunlight on post operative analgesic medication usage: A prospective study of spinal surgery patients. Psychosomatic Medicine,67(1), 156–163", 2005.