'HEALING ARCHITECTURE': DAYLIGHT IN HOSPITAL DESIGN

S. ARIPIN[1]
[1]School Geography, Planning and Architecture
University of Queensland
AUSTRALIA

Abstract

Recently, the move by the Malaysian government to reduce the energy consumption in public buildings including hospitals is seen as the call for sustainability in the built environment. On the other hand, designing a hospital building is generally accepted as a complex task both: functional and psychological. At this juncture, creating a healing environment with appropriate physical aspects (i.e. daylighting) to achieve sustainable hospital design seems relevant and in tandem with sustainability. Much literature suggest that adequate and appropriate exposure to natural light provides a positive impact on human health and well being of patients and medical staff in a hospital environment.

The paper reviews the role of daylighting design as one of the physical aspects in hospital design to create a healing environment. The effects of physical aspects on patients' outcomes are highlighted. Pilot studies on Malaysian public hospital buildings are carried out to investigate the design and implementation of lighting (i.e. artificial and natural light) and its relationship to other environmental factors. Key findings on the physical aspects affecting daylighting design in 4-bed ward environments are explicitly noted. The paper calls for a comprehensive consideration on the physical aspects (i.e. daylighting design) in a healing environment as a strategy for implementation on a sustainable hospital design. Beyond this, good daylighting will obviate the need for artificial lighting, thus also lead for energy conservation, contributing to sustainability.

Keywords: Healing Architecture, Healing Environment, Hospital Design, Lighting.

1. Introduction

The call for sustainability or *green building* in the healthcare system is a paradoxical situation. Does it treat sickness or promote the condition of health? In hospital building, it is difficult to conceive the link and benefit of sustainability in contributing to the patients' health outcomes. Perhaps, to explain this, discussion evolving sustainability in healthcare facilities should embrace the notion of creating a supportive environment in hospital design (i.e. healing environment) that is physically healthy and psychologically appropriate. As a matter of fact, it should be the aim of designing a hospital. For this, it is an imperative for the physical aspects to be considered in hospital buildings. The physical aspects (i.e. daylighting, window design, thermal conditions and others) should be cleverly designed to achieve the balance and the principles of economic, social and ecological sustainability without compromising the functionality of hospital building (Linda, 2004). This paper emphasises two important aspects that lead to sustainability in hospital design: The importance of physical aspects to achieve a healing environment and the impact of the physical aspects (i.e. daylighting) on health outcomes.

1.1. Healing Environment in Hospital Design

In hospital buildings, where patients seek medical treatment and staff provides continuous support, creating a healing environment with appropriate physical aspects is an imperative to sustainable design. Nevertheless, the restoration of health and well being is not merely a matter of physical science (Day, 2007). The aspects of healing environment in hospital design are primarily important and relevant within the context of sustainability in healthcare facilities. The term *'Healing Architecture'* (Lawson, 2002) is adopted to invoke a sense of a continuous process; in creating an environment physically healthy and psychologically appropriate. A healing environment with appropriate physical aspects would indirectly contribute to patients' outcome such as shorter length of stay, reduced stress, increased patients satisfaction and others (Ulrich et al., 2004). One may agree to the idea that sustainable hospital design in the form of healing environment is achieved if these measurable outcomes could be quantified through appropriate design of physical aspects. Apparently, most scholarly literature does acknowledge that the existing physical environment we live in has an effect on our well being (Lawson, 2002; Day, 2007 and Todd, 2007).

Most healthcare designers accept the fact that designing a hospital is a complex task: both functional and psychological. Apart from building services, healthcare designers are expected to conform to various requirements provided by the Ministry of Health (MoH) which includes medical specialist requirements and equipment both for diagnostics and for treatment. In the effort to comply with the explicit requirements, it seems that most healthcare designers pay less attention to the ultimate aim of creating a healing environment. This has been well documented in most scientific literature that modern hospitals designed and equipped with technology for diagnostics, curing and treating have contributed to stress, depression and anxiety which have a harmful effect on health to patients and staff (Malkin, 1991 and Schweitzer et al., 2004). On the other hand, adverse experiences of existing hospital environment were recorded from visitors by the Commission for Architecture and the Built Environment (CABE) in the United Kingdom (CABE, 2004) and from patients' memories by Simini (1999). Critique would include terms such as confusing, dull, shabby, windowless, long circulation, glare and little natural light, poor lighting, noisy, sleep deprivation, isolation, physical restraint and want of information.

As a response to this, most literature in the healing environment have outlined that noise control, air quality, thermal comfort, lighting, communication, colour, texture, privacy and view to nature are among the physical factors which have to be thoroughly considered in hospital design (Malkin, 1991; Gross et al., 1998; Schweitzer et al., 2004 and Richard et al., 2005). These factors have a more pronounced influence in hospitals than in other buildings especially for patients who are bedridden or have limited freedom of movement. Ulrich (1984) established in a scientific study of a suburban US hospital that surgical patients who had view of nature through a window from their ward room not only spent less time in the hospital but required less analgesic medication as well. This study has spurred further tests and reviews by other disciplines involved with healing environments. They arrived at similar findings particularly that appropriate physical environment in the design of hospitals can ensure better health outcomes to patients, staff and visitors physically, mentally and psychologically (Horsburgh, 1995; Jones, 2002 and Lawson, 2002). In short, careful consideration of the physical aspects would significantly contribute to create a better healing environment which brings about sustainable hospital design.

1.2. Daylight and Health

Hosking and Haggard (1999) noted that creating a healing environment is not like building up a garage workshop, where cars are sent for repairs before continuing their journey. It is an imperative for a hospital environment however, where 'repair' of the body (i.e. healing) is the concern, to have the optimum level of comfort and care physically, socially and symbolically. For this the luminous environment plays an important role and an integral part of the hospital's healing environment. As a matter of the fact, natural daylight is often regarded as part of the healthy environment. Therefore, daylight is required in most areas in hospital buildings and is one of the crucial physical aspects to be considered in the healing environment. In the hospital wards indoor environment, appropriate window design would allow the potential benefit of daylight to be experienced by patients and staff. Their physical attributes are intertwined in the healing environment of hospital wards (Markus, 1967 and Todd, 2007).

Numerous studies have indicated that daylight has significant effects on the well being of humans both physically and psychologically. In fact, it has been recognised for many years that light has a significant effect on our circadian rhythm (i.e. biological cycles that repeat 24 hours). Campbell et al. (1988) imply that light is the most important environmental input in controlling bodily function after food (La Grace, 2004). Similarly, CABE (2004) clearly indicate that access to natural light is one of the crucial factors affecting patients' recovery. The presence of visible light in an indoor environment does influence the physiological responses, mood as well as visual needs (Schweitzer et al., 2004). Most psychiatrists generally agree that seasonal affective disorder (SAD) with symptoms of depression; fatigue and irritability may be triggered by shorter hours of exposure to daylight due to the seasonal change (Morriss, 2001, Evans, 2003 and Bower, 2005).

Research evidence by means of observations and qualitative analyses has found that lighting strategies (i.e. combination of daylight and artificial light) in a controlled environment have a positive impact on managing behavioural disturbances of the Alzheimer's type (Noell-Waggoner, 2002). In this aspect, most physicians together with other studies are in agreement in their findings that appropriate balance of daylight and artificial light may positively affect for Alzheimer's patients (Campbell et al., 1988; Noell-Waggoner, 2002 and La Grace, 2004). Therefore, related issues with regard to good lighting design in the hospital wards

should be taken to task seriously. Issues which are crucial factors in achieving a healing environment would include glare control, flickering-free lighting, orientation of the light to the visual task, colour rendering and temperature, and balance between electric and daylight.

Much literature do suggest that access to daylight not only has a positive impact on patients' outcomes, it can also provide restorative benefits to other users in their respective environments such as medical staff, school children and office workers. In a survey conducted in a hospital environment on access to natural light Jana et al. (2005) claim that 70% of the medical staff rated increased natural light as having a positive impact on their work life. CABE (2004) produced similar findings that improved physical environment has a significant influence on the nurses' performance in their work and has positive impact on their recruitment and retention. Another study by Kuller and Lindsten (1992), in a selected class of a school environment, found that absence of daylight may influence children's performance and eventually have an impact on annual body growth and sick leave. However, the quantitative relationship of daylight and productivity has not been established.

In short, these findings and others provide compelling evidence on how daylight may influence human health, behaviour and performance. For this reason daylight in hospital design should rigorously be pursued as one of the physical aspects in creating a healing environment. However, it is believed that experimental studies of daylighting in hospital design are very few and far in between. Many studies on the subject of daylight focus on schools, offices and commercial buildings but few on hospitals. Therefore, the present study calls for a comprehensive consideration on the physical aspects (i.e. daylighting design) in a healing environment as a strategy for implementation on a sustainable hospital design. Daylight should be incorporated into lighting design in hospital buildings, not only because it is beneficial to patients and staff, but also because it is light delivered at no cost. Adopting and implementing good daylighting will obviate the need for artificial lighting, subsequently lead for energy conservation, contributing to sustainability.

2. Methodology

An extraction and assembly of the body of knowledge and on-going research of healing environment in hospital design is apprehended in this paper. It is intended to identify potential research areas on the physical aspects of healing environment in hospital design particularly in daylighting. Methodology employed in this research is literature review, desktop analysis and pilot studies of hospital buildings.

2.1 Literature Review

Aspects of healing environment in hospital design which include the physical aspects, daylighting and its effects on human beings are critically reviewed. An understanding of the subject of 'healing architecture' is established to provide substantial evidence on the link between the physical aspects of hospital environment and human health physically, psychologically and mentally within the context of sustainability. For this, desktop analysis through the thematic and content reviews is to provide clear arguments on the subject discussed. A cross examination of the project briefs (medical, architectural and engineering briefs) of Malaysian public hospitals is to investigate the provisions of physical aspects in the design. Three public hospitals in Malaysia are then identified for the pilot studies.

2.2 Pilot Studies

The critical examination of the existing conditions of physical aspects is carried out in a pilot study of three public hospital buildings in Malaysia. Criteria of building type (i.e. healthcare facilities) and level of care in the Malaysian healthcare system are explicitly listed out and the focus area for the analysis is clearly established. A critical analysis is expected to arrive at key findings on the physical aspects of ward environment. Patients and medical staff are used as subjective testing and their experiences will be explicitly noted to substantiate the personal observation made.

3. Pilot Studies: Public Hospitals in Malaysia

3.1 Brief Description

In accordance to the Malaysian healthcare referral system (i.e. a concept defined by World Health Organisation (WHO) as a channel of filtering and referring patients to appropriate care), the progress of the physical development of healthcare facilities has been rigorous since independence in 1957. It encompasses primary, secondary and tertiary level of care. The medical approach of promotive, preventive, curative and rehabilitative is being refined and implemented at all levels of care (Suleiman and Jegathesan, c2000). The Ministry of Health Malaysia (MoH) is responsible for establishing a framework to ensure that the health system could develop and adapt the changing environment and need.

In the context and limitation of this study, three Malaysian public hospital buildings are selected namely Selayang Hospital, Serdang Hospital and Sultan Ismail Hospital. These hospitals are categorised by MoH as *'referral hospital'* (i.e. patients must be referred by other medical professionals before they are seen and would receive treatment). The *'referral hospital'* will eventually become specialised (e.g. liver, hand and micro-surgery cases for Selayang Hospital and lung cases for Serdang Hospital). Based on the information gathered, it has been found that the medical brief, technical and environmental requirements prepared by MoH and Public Works Department Malaysia (PWD) were first established for Selayang Hospital to function as referral hospital with '*paperless'* technology. The project brief of Selayang Hospital was further refined for Serdang Hospital and Sultan Ismail Hospital. The common parameter (i.e. same project brief used) has been the basis for the selection of the pilot studies. Further similarities in the pilot studies selected as referral hospitals set by the Ministry are found in their technical requirements, complexity, level of care, day to day operation, number of beds, location and building heights. Interestingly, the outcome of the hospital environment varies in their design approach, building configuration and concept. The implementation of *'one-off'* design hospitals with different outlooks is a result for the calls made by MoH to be ecologically sustainable and environmentally friendly. Furthermore, the change of procurement system from traditional to design and build could have been the driving factor for *'one-off'* hospital design (Aripin, 2006).

These *'one-off'* hospital designs in Malaysia with different outlooks and mechanical aids do not necessarily conform to the principle of sustainable design. These may lead to energy waste, confusion and other negative aspects in the functioning of the hospital. Hence, the ultimate aim of creating a healing environment for staff, patients and visitors physically, mentally and psychologically may not be achieved. To establish this concern, investigation on the provision of the physical aspects of the selected public hospitals design in Malaysia is relevant and pertinent.

3.2 Methodology and Scope of Work

The main objective in conducting the pilot studies is to investigate the implementation of the physical aspects in a healing environment of *'one-off'* hospital designs in Malaysia. Gathering such primary data would enhance the body of knowledge of daylighting in the context of Malaysian climate. Visits to the three hospitals were made separately with a minimum 4 to 5 days stay at each building. The physical conditions of 4 bed ward indoor environments were used as the subject to be reviewed.

The reviews made are qualitative; based on the researcher's critical observation and understanding on retrospective studies of both aspects: healing environment and daylighting in hospital wards. The primary data gathered is further enhanced and confirmed by the information received from the medical staff working in the wards. The key findings will focus on the physical aspects affecting daylighting design in the ward environment emphasising on physical design and the implementation of lighting and its relationship to other environmental factors. These would include building orientation, window design, access to view, visual comfort of the ward environment, lighting (daylight and artificial) and colour. These are the most pronounced influential physical factors affecting bedridden patients. In the following text, the three referral hospitals in the pilot studies will be identified with acronyms: Selayang Hospital with SH-1, Serdang Hospital with SH-2 and Sultan Ismail Hospital with SIH.

4. Findings: Physical Aspects Affecting Daylighting Design

The physical factors affecting daylighting design have been identified in the pilot study of 4-bed indoor wards environment. The key findings on the physical aspects are explicitly noted qualitatively based on the critical observation and subjective testing. Hence, analysis is required in the next study to corroborate the qualitative observation and opinion with the quantitative data of luminance and illuminance of daylight in the ward environment with regard to visual comfort.

4.1 Building Orientation

In hospital building, orientation plays a major part in the early process of the design. In fact, it can be argued that is the highest priority in the design decision for achieving sustainable hospital environment. Regrettably, a preliminary finding seems to indicate that most healthcare designers regard physical planning issues as the topmost priority to be sorted out at the early stage of hospital design. This is due to the fact that designing a hospital building is generally accepted a complex task both: functionally and psychologically.

In theory, the decision on building orientation will subsequently influence the design of the physical aspects (i.e. shading devices, window opening, placement and profile). Similarly in hospital design, where creating a healing environment is the primary concern, orientation of the building does influence the design of the windows directly affecting the quality of daylighting (i.e. glare effect and daylight distribution) and access to outside view (i.e. optimise the surrounding scenery). Hence, it would have a significant impact on the end users' (i.e. patients, medical staff and visitors) experience and well being. Providing access to outside view through a window would provide patients in the ward environments with a sense of orientation and connection to the external environment. Absence of this would have a negative impact on building users' as discovered by Verderber and Reuman (Jana et al., 2005). Investigation conducted in the pilot studies on building orientation illustrates the following:

4.1.1 It has been found that in the SIH building; most of the 4-bed wards are placed to face North-South direction. As a result, no direct bright light appears on the floor surface of the ward during the day. Most importantly, disability glare or discomfort glare are avoided. This would certainly be the outcome if the building orientation is placed in East-West direction, allowing the main elongated façade to face North-South.

4.1.2 Nevertheless, the SH-1 and SH-2 hospital buildings are not exactly oriented in the East-West directions. As a result, it is estimated that 20 to 30 per cent of the 4-bed wards are almost directly facing East and West. This results in the wards having direct bright light (at low angles) on the floor surface of the wards at certain period of the day. Consequently, patients and staff do experience unwanted warmth and discomfort glare.

4.2 Window Design

In the research fraternity of healing environment, there is a growing consensus recognising the window as one of the most significant physical aspects for patients and medical staff physically, psychologically and mentally. There are two benefits of windows: one is daylight and the other is view. In an empirical research conducted by keep and others as quoted by Jana et al. (2005); of two groups of individuals in the intensive ward therapy unit: one was unit without windows, and the other with translucent windows; indicates that patients with translucent widows were more oriented during their stay and gain better health outcomes such as avoiding sleep disorders, hallucinations and delusions. Even with translucent windows in this aspect do provide the vital link to the outside world for patients and the feeling of orientation helped to maintain their normalcy (Jana et al., 2005). Conversely, a well designed window is not an intuitive task; it requires careful architectural, environmental and cultural considerations (Todd, 2007). The following account is an investigation on window design in the pilot studies:

4.2.1 A survey conducted in the three Malaysian public hospitals indicates that the need and importance of windows in the wards environment are clearly acknowledged by all parties (i.e. patients, medical staff, healthcare designers and providers). It has been observed that windows are provided in all 4-bed wards in the pilot studies.

4.2.2 Windows in all hospital buildings are specified as tinted glass with various degree of darkness: dark tinted for SH-1 building, blue tinted for SH-2 building and light dark tinted for SIH building. The connection to the outside world with tinted windows may not be an issue to patients but it may affect their judgments on outside weather. Nonetheless, it can be observed that tinted windows help to reduce the brightness of outdoor sunlight.

4.2.3 It has been noticed clearly that the provision of windows in all 4-bed wards in the pilot studies is different in term of windows' profile and placement. Two types of windows' placement have been identified in all three public hospitals and it may have some impact on access to outside view for patients in relation to their beds. Type A window placement has been adopted by SH-1 and SH-2 buildings which is categorised as *symmetrical and balanced*: the 2 panels of windows are located symmetrically at both sides with a blank wall in the middle. The placement appears to be balanced. Type B window placement is categorised as *centre grouping*: the 4 panels of windows are grouped and located at the centre of the perimeter wall. The placement seems to be centralized. This type B placement has been adopted by SIH building. Based on the observation made on these two types, it can be deduced that either patients in a lying or sitting position on the bed, it is most preferable to have window placement of type A (i.e. symmetrical and balanced) in a 4-bed ward environment. It has been noticed that two patients from their bed positions have a better chance to have access to outside view through type A window placement. The justification would be the ratio of 1:2 (windows to patients) for type A: *symmetrical and balanced* placement whereas, the ratio of 1:4 for type B: *centre grouping* placement. Another aspect which has been noticed on the consequences of window placement is that different outcome of daylight distribution in the ward environment in either type of placements. However, this has to be quantified by means of measuring the luminance and illuminance of daylight distribution in the next study.

4.2.4 It has also been observed that the overall window surfaces in SH-2 building may appear to be more than the other two hospital buildings (i.e. SH-1 and SIH). As a result, the two beds near the windows are warmer than the other two in a 4-bed ward environment. The observation and experienced had been confirmed by the ward nurse during the visit to SH-2 building that they received complaints from the patients who had been regularly admitted to the same ward. The patients would normally request not to be positioned near the windows. Evidence based design such as this has confirmed that the conflicting issues *'physical to physical'* (e.g. daylight vs. heat gain) and *'physical to psychological'* (e.g. daylight vs. undesirable glare) have to be addressed.

4.2.5 Another critical observation has been explicitly noted is that daylighting method and strategy seemed to be designed intuitively. Only horizontal concrete shading devices are provided for SIH building however, its effectiveness is not convincing. Implementation of daylightng design appears to be very limited in all hospital buildings. Articulation of daylighting through window treatment is rarely found. This aspect is extremely important and relevant for building design in a Malaysian climate (i.e. tropical climate) particularly in a healing environment which would contribute to the sustainable hospital design.

4.3 Access to View

There is growing research evidence that access to view in the ward environment would provide a positive impact on patients physically, psychologically and mentally. Evidently, research by Ulrich (1984) of surgical patients with a view through a window may provide shorter length of stay. This evidence and findings by others send a clear message to the professionals involved in the healthcare services that coordinated effort must be taken beyond the requirements of the project briefs. Initial investigation on the hospital project briefs proves that there is no requirement explicitly stated emphasising this aspect. On the same tone, the quality of outside view has to be positively promoted in a ward environment for patients and staff psychological well being: view of a children playground instead of a view of a blank wall. However, in reality of the building design, the availability of view for the users is not always positive quality. In healthcare design, to achieve quality view depends highly on the site selection, building orientation, wards layout, bed positions and windows design. Further investigation conducted in the pilot studies on access to outside view reveals the following:

4.3.1 An average measurement of the window height from the finished floor level in all 4-bed wards of the three hospital buildings is 1000mm. Subjective testing was conducted at level 4 of SH-1 building in a 4-bed ward environment with a panoramic view (i.e. greenery of hill, trees and sky), at the extreme bed position (i.e. the farthest from the windows) in both situations: lying and sitting on the bed. It has been discovered that a minimal view of the trees (about 5% of the view in a standing position) can be seen from the bed when a patient in a sitting position. However, when a patient in a lying down position on a bed, it has been found that only view of the sky can be seen. This indicates that access to positive view (i.e. greenery) by patients is even more critical when the wards are at a higher level. Assumption has been made that when one is at the highest level of the building, view of the surrounding area would be most enjoyed. This could have been true for other building functions in a standing position but may not be applicable in hospital buildings when the patients are bedridden.

4.3.2 Bed layout and windows placement may affect access to view by patients in the 4-bed wards environment. As mentioned in the section of windows design, SIH buildings has adopted window placement type B: *centre grouping* (see 4.2) at the parameter wall of 4-bed ward environment. It has been discovered that access to view by patients is almost being denied due to the narrow angle from their bed positions. Healthcare designers may not be aware of this phenomenon until the subjective testing playing the role of a patient is conducted and experienced.

4.3.3 On the aspects of the availability of outside view in the 4-bed ward environment, the study arrives to three different types of outside view: Type 1 is of panoramic view (greenery with open field and housing development in surrounding areas), type 2 is of building facades own view and type 3 is of a blank wall (a coloured blank wall). It has been noticed that patients experience view of type 1, 2 and 3 in SH-1 building, whereas, views of type 1 and 2 are experienced by patients in both SH-2 and SIH buildings. From the study, it can be deduced that wards with outside view of type 3 (i.e. coloured blank wall) is the worst quality of view experienced by patients in SH-1 building. Strong dissatisfaction was expressed by patients in these wards. It has been estimated that 25% of the 4-bed wards facing view of type 3. This is in fact due to the building configuration of the wards are arranged in the form of a letter 'W'. It has been confirmed by nurses that regular admitted patients in the wards facing view of type 3 have requested to transfer to the opposite wards. Unfortunately, the request could not be met as the opposite ward is provided for the opposite gender. Evidently, the quality of view in ward environment does psychologically influence patients' well being.

4.4 Visual comfort

4.4.1 It can be deduced that the visual comfort of a 4-bed ward environment in all hospital buildings has been generally satisfied under both sky conditions (clear and overcast) during the day. However, it has been explicitly noted that discomfort glare was experienced by patients at a particular time at some of the 4-bed wards in all hospital buildings (SH1, SH2 and SIH). It has been noticed that patients had to either use curtains or not facing the window to avoid discomfort glare when lying on the beds near the windows. Therefore, physical conflict does occur between wanting to have a view and avoiding direct disability glare. Nevertheless, to corroborate the patients' view and observation on glare, the question must be further pursued in the next study with the analysis of in-situ measurements. It can be generalised that tinted windows help to reduce outside bright light condition, but it did not resolve issue of discomfort glare.

4.5 Lighting (Daylight and Artificial)

4.5.1 In most of the hospital buildings visited, access to daylight in the 4-bed wards environment seems to be sufficient during the day under both sky conditions: clear and overcast. Patients were observed not to be keen to switch on the artificial lights unnecessarily during the day. However, artificial lights were required in between 5 to 7pm depending on the sky conditions and heavy rainfall.

4.5.2 In all 4-bed wards environment, the artificial lighting at the ceiling is noticed to be arranged along the centre line of the wards' space and not located above patients' bed. Insufficiency of lighting conditions has been confirmed by nurses when retractable dividing curtains had to be pulled during the conduct of medical procedure on patients. It has also been noted that some patients experienced

discomfort glare from the artificial lighting at the ceiling when they were in a lying position on the bed for resting.

4.5.3 It has also been observed that the size of the artificial lighting at the ceiling is inconsistent. For instance, smaller size of 600mm x 600mm square box of fluorescent luminaire has been found used in the SIH building instead of 600mm x 1200mm rectangular box luminaire in the other two hospital buildings.

4.6 Colour

4.6.1 In the study, pastel colour scheme is used in almost all 4-bed wards environment. Patients seem to be satisfied on this aspect. Wards and levels are differentiated by means of different colour schemes and tones for SH-1 and SH-2 buildings. It has also been noted that in the 4-bed wards environment of SH2 building, perimeter walls are painted with dark colours (e.g. dark green) instead of continuous pastel colours, thus increasing the luminance contrast with adjacent windows. It is important to note that this requires further analysis on the aspect of reflectance of daylight, as it may have an effect on the perception of patients' skin colour subsequently affecting the visual task of doctors during medical examination.

Conclusions

Achieving sustainable hospital design through appropriate physical aspects is not an impossible task. The growing research evidence and the pilot study conducted in the Malaysian public hospitals provide unequivocal direction to suggest that the physical aspects have a significant role in creating a healing environment. In the context of hospital buildings, the measurable patients' health outcomes in a healing environment are indirectly the result of appropriate design of physical aspects. Thus, the role of daylighting as one of the physical aspects having a significant impact on the well being of the patients, staff and visitors. It is without doubt that well designed daylighting will obviate the need for artificial lighting. The effort to reduce dependency on artificial lighting would directly contribute to the energy consumption of hospital buildings, subsequently assisting sustainability.

Creating a healing environment with appropriate design of physical aspects (i.e. daylighting) in hospital buildings in Malaysia should be rigorously pursued. Professionals in the healthcare services should be inspired with the availability of natural environment (i.e. daylight and natural view) in the Malaysian climate without sacrificing clinical functionality and design visions. One must accept the fact that the subject of healing is a multidisciplinary discipline. Thus, a coordinated effort by healthcare professionals and others (psychologist and lighting specialist) will be able to achieve a better hospital building not only for healing environment that is physically healthy and psychologically appropriate but also for aiming to contribute sustainable design.

The effort to have *'one-off'* design for public hospital in Malaysia through improved procurement system is a commendable starting point. However, stringent requirements on the physical aspects to meet environmental issues should be explicitly stated in the design briefs of hospital developments. These requirements must be conform by healthcare designers and validated by the healthcare providers. The present scenario suggests that healthcare designers ought to consider issues beyond the project brief and requirement. It should be noted that conflicting issues in hospital environment: *'physical to physical'* (e.g. daylight versus solar heat gain) and *'physical to psychological'* (daylight vs. undesirable glare) can only be resolved with good understanding of daylighting design. In conclusion, the study embarked upon the physical aspects (i.e. daylighting) of healing environment in hospital design could significantly reinforce the project briefs provided by the healthcare provider (Ministry of Health Malaysia).

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