Role of daylight in local hospitals design

Hasan Shakir M. Alboadam and Younas Mahmoud Mohamed
Department of Architectural, University of Technology-Iraq
E-mail: ae.20.42@grad.uotechnology.edu.iq

Abstract. Environmental sustainability is one of the most important, and one of the sustainability criteria is Daylight that trying to provide it in hospital spaces and which improve the patients status(healing of patients), by looking at studies concerned with the role of Daylight in the design of local hospitals, we find a knowledge gap emerged regarding the lack of studies that dealt with the design of Daylight in local hospitals and its effect on the healing of patients (a special problem for the research). The goal of the research is to determine the role of Daylight in hospital design. Research hypothesis: the Daylight affect the healing of patients at local hospitals by achieving comfortable zone at patient room and this affected by the orientation of these rooms and relationships between the location of head of patient and the TV wall at these rooms, in the practical side we select two hospitals and prepare the sites measurements by using LUX meter instrument, In this aspect, the intensity of the light and the indicators associated with it were measured, as a group of patients rooms were elected on multiple facades of the hospital building, as these rooms were numbered and their location in the plans based on the numbering system in the hospitals and then the details of the room were determined dimensions, the window's location and its relationship with the bed, the location of the patient's head in the room and the location of the TV wall (the front facing the patient's head), as a mock net was drawn 95 cm from the ground level and the net was 50 cm away from the walls and the distance between One point and another is approximately 85 cm in both directions, and a mock square grid (2 meters * 2 meters) was drawn on the wall opposite the patient's head (the TV wall) and the distance between one point and another is 50 cm. If the hospitals' engineering plans were obtained, then the rooms for the patients' rest were elected in the wards, provided that every two rooms were facing each other in the same wing after the sun's movement was determined. The direction of those rooms was determined. The research reached a number of conclusions on designing natural lighting in local hospitals and determining within measures specific to the Iraqi environment. The most important conclusions of the eastern and southern directive were the orientation of the eastern and southern patient rooms to better rooms for patients, which in turn helps to heal patients.

1. Introduction
Hospitals are considered one of the most complex institutions due to the work natures and the privacy of dealing between their components, which need accuracy in achieving their functional and mobility requirements. They are also one of the institutions that must be operational and effective in different circumstances and have the first role player in rescue when natural disasters pandemics and Risks.

Daylight's importance in hospitals is that it has become a global trend to rely on natural resources instead of finding alternatives that have negatively affected the planet due to their byproducts such as carbon dioxide and natural resources as fossil fuels other materials. Also, Daylight has a positive impact on inpatients psychological side, as studies have shown that patients exposed to Daylight are characterised by good health, shorter stay time and less pain. Locally, attention to using Daylight in hospital design is still little. We find a knowledge gap regarding Daylight studies in local hospitals and its effect on patients' healing (a special problem for the research). The research goal was identified: For adequate Daylight in achieving a locally sustainable hospital building).and the objective of the research was to determine the appropriate daylight design indicators for the local, sustainable hospital.

2. The role of Daylight in hospitals
Daylight exposure decreases stress among patients. Suffering from “The “bipolar illness” successful seasonal condition decreases stay in the hospital, improves circadian rhythms, decreases patient excitement and apprehension, relieves discomfort, and improves employee adaptation to work at night). Since patients have shorter stay times in east-facing rooms than patients in west-facing rooms, in the morning, exposure to bright light is more effective at minimising depression than at night. (Less stress, less pain, 22% less pain medication, 21% fewer drug costs). [1]. Daylight’s effect in intensive care rooms was also found to affect myocardial infarction patients treated in either sunny or windowless rooms. [2] The capacity of nurses is another consideration with regard to lighting in hospitals. [3] Figure 1.

As studies have shown, patients have shown that patients exposed to Daylight are characterised by good health, shorter stay time, and less pain. Locally, attention to using Daylight in hospital design is still little. We find a knowledge gap regarding Daylight studies in local hospitals and its effect on patients’ healing (a special problem for the research). The research goal was identified: For adequate Daylight in achieving a locally sustainable hospital building). the objective of the research was to determine the appropriate daylight design indicators for the local, sustainable hospital.

Several factors affect the physiological nature of individuals from the point of view of ecological architecture. Human health and comfort in the environmental design are major concerns. "Comfort" is, however, a fundamental necessity for human wellbeing. "Feeling contented” is an optimistic concept of comfort. This concept is based on environmental factors. Thermal condition, Humidity, consistency of indoor air, visual ease and acoustic comfort.

Nowadays, by taking advantage of external environmental variables, engineers can improve patient rooms’ internal outmosfer. As a result, the indoor room is well-adapted for physical and psychological comfort to meet the patients’ environmental requirements. Both environmental factors in healthcare facilities may also benefit patient outcomes if they can design it properly.

3. Concepts of the role of Daylight in the indoor environment

The perception of light is influenced by several principles, which can be explained as follows:

First, the light intensity is an essential factor that must be taken into account; It is the cumulative amount of light on a given surface. Lux is a measuring unit. The light intensity changes during the day and even between the seasons due to the sun’s shifting positions and the differences include visibility in the sky[5].

The degree of lighting and its distribution throughout spaces reflect this transition, and this occurs with the difference in illumination adjacent window and the back of .room,[5].The light concept period varies according to the season and the sky's state [6]. Daylight's duration on a winter day is shorter than in summer. Also, there were differences in lighter, the blue light was significantly less on winter days, while red and green light was higher in winter days. [7].

The colour of the illumination depends on the wavelength of the light. Colour vision is caused by separate wavelengths [8]. During the day, the daylight colour varies, morning, you can find a blue spectrum and red spectrum afternoon till evening [9], the colour wavelengths are shown in Table no1, Hormones like cortisol and melatonin are secreted associated with light colours [10]. The blue spectrum causes a spike in cortisol, so the cortisol level is at its peak between morning and afternoon. Cortisol raises the energy level of an individual, which contributes to the ability to perform long-term tasks. The melatonin level interacts with the red spectrum, leading to an evening rise in melatonin. The sleep hormone is also referred to as melatonin, and the rhythm of sleep and waking up is regulated by one of its functions. It can be concluded from this that Daylight causes an increase in energy levels during the day and that Daylight causes an increase in melatonin levels. Serotonin is the third hormone that is affected by illumination. [11] In their research, sunlight may affect serotonin development directly through the skin. Serotonin is classified as a pain suppressant hormone. [12]

Table 1: The relationship between hormones and Daylight
### The name of the hormone

| The name of the hormone | Spectrum | Time of effects | Action | Location |
|-------------------------|----------|----------------|--------|----------|
| cortisol                | blue     | morning        | energy | pituitary gland |
| Melatonin               | red      | evening        | Sleep rhythm regulator | pituitary gland |
| serotonin               | Light    | daylight       | reduce the feeling of pain | the brain |
| VitaminD                | Light    | daylight       | reduce the feeling of pain | Under skin |

### 4. International applied practices

Emphasis will be placed on applications of some international hospitals in the field of Daylight to building a comprehensive theoretical framework for Daylight in hospitals, within their indoor spaces as follows:

#### 4.1. Mediplex Sejong Hospital, Incheon, South Korea

The hospital build on 1996 (18 floors) in Incheon Korea. The climate in the city is continental and seasonal, it consisted of the southeast and northwest facing a single T-shaped building. There were similar and identical spaces, finishes, furnishings and equipment for all patient rooms. The data (direction of each patient's room and the position of the patient's head relative to the window) were categorised according to the data—every wing in the hospital of choice, Figure 2.

![Figure 1: Shows hospital patient rooms A and B, depending on the location of the patient's head in the room](image1)

At the site, a set of points were determined for measurement. As measurements were made on-site for each selected room according to the previously mentioned points, The reflection of the inner room's surface was measured, and the glass was tested. At the height of 0.95 meters from the ground in the study, four reference points were selected. The levels of patient rooms and lighting were assessed.

#### 4.1.1. The availability of Daylight

There were some variations in daylight distribution and intensity, depending on the patient's bed location. Room No. 6, for instance, is situated in the corner between the patient's wing and the main building (Figure 3), although the Daylight would not be bright in the early morning relative to room No. 1, even though both are focused in the same direction.

![Figure 2: Types of patient rooms and room numbers in the wing](image2)

![Figure 2: Pic of the patient room show the relation between bed and window](image3)

#### 4.1.2. Luminance ratio (LR)

The luminance ratios between the TV and the adjacent wall and between the TV and the eye from direct and indirect natural light were within the range of the prescribed
guidelines when the blinds were open, with a maximum of 40:1 and 10:1, respectively. There were some cases, on the other hand, which were higher than the allowed rates. The brightness ratio revealed moments of 90:1 on the TV wall, in the Form A room facing the SE, or greater, particularly in the mornings in the spring (compared to other seasons). However, if this high luminance ratio needs to be avoided by the patient, the blinds may well be closed to reduce the high 8.6:1 maximum incidence, which is smaller than the prescribed ratio. Naturally, the SE room had a higher capacity for LR luminance than the NW room in the morning and in the afternoon and vice versa.

4.1.3. Diversity of illuminance (DI). Lighting diversity patterns were similar in every direction since they are closely correlated with illumination levels. The light diversity values are usually higher than the Chartered Institute of Construction Services Engineers (CIBSE). Research Conclusions:

a. There is a clear relationship between the patient's stay time and the natural light environment.

b. By installing suitable shading devices, the discomfort caused by excessive daylight glare can be resolved. The high luminance ratio, brightness diversity, and brightness level can be managed and modified according to the values recommended by CIBSE and IESNA.

c. Patient-controlled shading has a positive impact on the comfort of patients and enhances patient satisfaction.

d. It may be conducive to rapid recovery to recognize disease types and the physiological benefits offered by Daylight.

e. High lighting was more beneficial in the morning than it was in the afternoon. For patient rooms that are southeast-northwest-oriented, for more details and to reach practical indicators for Daylight's role inpatient rooms, international hospitals have been addressed, which have adopted the strategy of Daylight, as shown below.

4.2. ST. JOSEPH REGIONAL HEALTH CENTER Texas, USA

Hospital build in Texas. This hospital is divided into Building A and B sections due to each building's different daylight conditions. Half of the patient rooms face south and half face north, respectively. Figure 4:

| Name                  | Details               |
|-----------------------|-----------------------|
| Window area           | 2.2m2                 |
| Type of glass         | Double insulated      |
| UV paint              | none                  |
| Window / wall Ratio   | 0.17                  |
| Window / floor Ratio  | 0.3                   |

**Figure 3:** Patient room diagram and data and the front of the block contain the patients’ rooms.

The patient's room has a long window that is difficult to open. Both walls and ceilings are concrete, and the windows are double-glazed and insulated, Figure 5. St. Joseph Regional Health Center's patient rooms are symmetrically built according to the location of patient beds (head to head and foot to foot) and divided by a wall, Figure 5.
First: lighting variables. The patient rooms' internal environment components were calculated (daylight factor, brightness ratio, average brightness, diversity of lighting, uniformity of illumination). Conclusions of the study:

- Exposing them to Daylight in the morning reduces the length of stay in the hospital to a lesser period than rooms that are not exposed to the morning sun.

- Second, installing suitable shading devices, the discomfort caused by excessive daylight glare can be resolved, and the luminance ratio, brightness diversity, and degree of brightness can be managed and modified according to the values recommended by CIBSE and IESNA.

(CIBSE - Chartered Institution of Building Services Engineers, Illuminating Engineering Society of North America)

4.3. MEDICAL CENTER YONSEI, Seoul, South Korea

Has 300 beds for patients (ten floors), Figure 7. Fifty percent of patient rooms are facing southeast, and the majorities are facing northwest. Patient rooms have been chosen from each direction in each wing by random sampling. In grids, 0.5 m x 0.5 m, illumination levels in the sampled patient rooms were measured 0.85 m above the surface. Measurements were taken with a Minolta T-1H light meter at approximately 25 points in each room.

The effects of Daylight on the stay of the patient in the hospital statistically show:

- Patients staying in rooms with higher daylight levels were less likely than those staying in rooms with lower daylight levels.

- The Daylight is a higher southeast-facing patient wing, than in northwest-facing rooms

- In southeast-facing tumour rooms and in-wings, patients admitted left the hospital 4.5 percent and 8 percent earlier (respectively) relative to the northwest-facing rooms.

- The difference in indoor Daylight inpatient rooms can also contribute to greater patient stays in the hospital.

5. Indicators for designing Daylight in hospitals.

- Previous international studies have shown that there is a strong relationship between daylight design and patient recovery. This fact has been proven through statistics in hospitals with
linking the length of stay of patients to the rooms in which they were the location of those rooms in the building and the room's relationship to the sun.

- In this research, the indicators related to Daylight inpatient rooms will be analysed and the appropriate measures for the local Iraqi conditions and international standards. Where the internal daylight indicators consist of the following words: (daylight factor DF, IR ratio, level of light intensity, lighting diversity, lighting uniformity) which will be measured according to the following:

5.1. **Daylight factor DF**

It represents the optical ratio necessary for Daylight

\[
DF = \frac{\text{Indoor Luminance}}{\text{External Luminance}}, \quad \text{(Keith Robertson M. Arch (1999) p:4)}
\]

The values of 1.0% were determined for the daylight factor values as appropriate levels for the interior lighting of patient rooms, depending on the design values of the sky of Baghdad. According to this value for the daylight factor, the weights were placed in five levels according to this factor's achievement in the design, with an efficiency ranging (20% To 100%) Figure 7.

![Daylight coefficient weights](image)

5.2. **Luminance Ratio LR**

- **A.** The speed of adaptation and response of the eye, and avoiding the inconvenience of changes in lighting levels, the difference between the average luminance of the visual field / the rest of the field of view should have fewer differences. The recommended value does not exceed 1:40. Figure 8 shows the levels of lighting values achieved within the space for visual comfort.

- **B.** The discrepancy in the luminance ratios between the TV and the human eye does not exceed 1-10. Figure 9

![Distribution of degrees at the level of the chart the average luminosity of the field Of view (task) and the rest of the field of view](image)

![Ratios of lighting between the TV wall and the human eye](image)

5.3. **Luminous Intensity (Lux)**

Lighting and its distribution in and around the mission area have a significant impact on a person's pace, protection and comfort in perceiving the conditions and taking account of the following reasons: There are several different guidelines for activities according to the styles of building and room files for psychological and physiological aspects. The ideal recommended value is 100 lux (Figure 10).
5.4. Variety of Luminance (VI)
The luminous diversity index levels are expressed in terms of the highest illumination ratio to the lowest of it at any point in the working plane of the main area of the space or room 5: 1, Figure 11.

5.5. Illumination Uniformity (IU)
The standardisation of illumination deals with the patient's lighting conditions and the immediate environment. It does not extend to the entire room level, but the working level's lighting must be homogeneous. rate of not less than 80%

6. Local Practical application:
Hospitals have been elected that have a clear impact on the Iraqi community, as they are visited by the governorate and people of other governorates due to the presence of distinguished consulting services and staff to the multiple activities they provide. Accordingly, the following local hospitals were elected:
1- Al-Sadiq Teaching Hospital in Babil ............ Sample (A)
2- Najaf Teaching Hospital ............... Sample (B)

6.1. Al-Sadiq Teaching Hospital
A hospital in Babil Governorate with a capacity of 400 beds, Figure 13
The practical application was carried out on 9/9/2020, when the sky was clear and the average intensity of the external lighting was 93,000 lux, with direct light and 1420 lux in the shade. It took interior and exterior lighting measurements between the hours (11 am-2 pm). The measurements for indoor lighting were following the practical aspect as shown. The intensity of the light and the indicators associated with it were measured, as a group of patients rooms were elected in multiple facades of the hospital building, as these rooms were numbered and located in the plans based on the numbering system in the hospitals, and then details were determined and drawn. The room and highlighting the dimensions of the room, the location of the window and its relationship with the bed, the location of the patient's head in the room and the location of the TV wall (the facade opposite the patient's head), as an imaginary network was drawn 95 cm from the ground level and the network is 50 cm away from the walls and the distance between one point and another, approximately 85 cm in both directions.

Other an imaginary network was drawn on TVwall (2 meters * 2 meters) opposite the patient's head, and the distance between one point to another was 50 cm, and readings of all intersection points in the network were taken using a lux meter device. After the engineering plans of the hospitals were obtained, the rooms for the patients' rest were elected in the wards, provided that all two rooms were facing each other in the same wing after the sun's movement and the direction of those rooms were determined.

**Table 2:** the practical measurements in six rooms of Al-Sadiq Teaching Hospital

| Room | Illuminances of the Selected Points on the Horizontal Plane of the Patient's Room | Illuminances of the Selected Points on the TV Wall |
|------|---------------------------------------------------------------------------------|-----------------------------------------------|
| BA1  | 900 890 881 870 900                                                               | BA1 740 678 616 554 490 |
|      | 765 761 756 748 765                                                               | 629 580 533 484 438 |
|      | 635 633 631 626 635                                                               | 516 482 450 417 386 |
|      | 505 505 506 504 505                                                               | 403 384 367 350 334 |
|      | 375 377 381 382 375                                                               | 290 288 285 283 280 |
|      | 245 249 256 260 245                                                               |                                        |

**Figure 12:** determining the location of patient rooms in the hospital master plan

**Figure 13:** the Lux meter and the measurements in patients rooms

**6.1.1. Daylight factor DF.** The daylight coefficient differs from one space to another depending on the two variables, the level of indoor lighting and the level of external lighting, according to the
mathematical equation: \( DF = \frac{\text{indoor}}{\text{outdoor lighting}} \), to reach the daylight factor, the average lighting rate for patients' rooms was calculated

| Table 3: shows the percentages of the daylight factor |
|---------------------------------------------------|
| Patients room | BA1 | BA2 | BA3 | BA4 | BA5 | BA6 |
| Orientation   | Western | eastern | Southern | northern | Western | northern |
| Average interior lighting* intensity | 568 | 1113 | 1115 | 503 | 430 | 367 |
| Daylight factor for each space DF | %4 | %8 | %8 | %4 | %3 | %3 |

The average daylight coefficient for patients' rooms was 5%, concerning the daylight coefficient index in the previous paragraph (1-5), the achieved percentage: 20%.

*The average interior lighting intensity was taken through the points (24 horizontal points). The readings for these points were collected and divided/24.

6.1.2. Luminance Ratio. They include the following indications:

**B-1 the difference (average luminance of the visual field/rest of the field of view) is 1:40**

The lighting ratio was calculated for each of the selected rooms and was as follows, Table (3):

| Table 4: shows (average luminance of the visual field/task)/ field view |
|---------------------------------------------------------------|
| Patient rooms | BA1 | BA2 | BA3 | BA4 | BA5 | BA6 |
| Orientation | Western | eastern | Southern | northern | Western | northern |
| Lowest light intensity | 170 | 330 | 245 | 330 | 151 | 198 |
| Average light intensity | 568 | 1113 | 1115 | 503 | 430 | 367 |
| Illumination ratio | 1:2.3 | 1:5.6 | 1:3.2 | 1:1.4 | 1:2.8 | 1:2.1 |

To reach a uniform illumination ratio for the entire hospital, and from the ratios that he reached, the luminance ratio was \( LR = 1:2.9 \), concerning the luminance ratio indicator in paragraph (2-5 a), the achieved ratio: 100%

**B-2 the illumination ratios between the TV wall and the human eye do not exceed 1-10**

The brightness was taken on the wall opposite the patient's bed. The ratio was calculated between the wall's average illumination intensity opposite the patient's bed (TV wall) with the luminance intensity at the patient's head, Table (4).

| Table 5: shows the ratio of lighting ratio between the TV wall and the human eye |
|-----------------------------------------------------------------------------|
| Patient rooms | BA1 | BA2 | BA3 | BA4 | BA5 | BA6 |
| Orientation | Western | eastern | Southern | northern | Western | northern |
| The average light intensity on the TV wall | 450 | 656 | 826 | 221 | 395 | 463 |
| The intensity of illumination at the patient's head | 765 | 1615 | 1602 | 346 | 522 | 522 |
| The ratio of the intensity of illumination between the wall/head of the patient | 01:01.6 | 01:02.4 | 01:01.9 | 01:01.5 | 01:01.7 | 01:01.1 |

6.1.3. Luminance Level (Lux). The average light intensity was as shown in Table 5

| Table 6: Luminance Level Lux |
|-----------------------------|
| Patient rooms | BA1 | BA2 | BA3 | BA4 | BA5 | BA6 |
| Orientation | Western | eastern | Southern | northern | Western | northern |
| Light intensity rate | 568 | 1113 | 1115 | 503 | 430 | 367 |

6.1.4. The diversity of lighting DI. The lighting diversity in hospital rooms was measured as in Table 6
Table 7: Values of luminance diversity

| Patient rooms | BA1   | BA2   | BA3   | BA4   | BA5   | BA6   |
|---------------|-------|-------|-------|-------|-------|-------|
| Orientation   | Western | eastern | Southern | northern | Western | northern |
| Highest Luminous Lux | 610   | 1920  | 900   | 570   | 770   | 1980  |
| Lowest Luminosity Lux | 170   | 330   | 245   | 330   | 151   | 198   |
| The ratio of higher / lower | 01:04 | 01:06 | 01:04 | 01:02 | 01:05 | 01:10 |

The average light diversity values were 5.2: 1, and concerning (5-4), which indicated that the average intensity ratio of highest / lowest light intensity for all rooms does not exceed = 1: 5, so the ratio achieved: 0%.

6.1.5. Illumination uniformity (IU). It is required that the average light distribution of the work level be homogeneous, not less than 80% and Table No. (7) Shows the values of measuring the lighting levels inpatient rooms.

All patient rooms are homogeneous in terms of intensity of illumination near the patient's head, uniformity of illumination ratio = 1: 1 concerning paragraph (5-5), the achieved ratio: 100%

The values of the practical measurements and the results were as shown in Table 9.

Table 8: luminance uniformity values

| Patient rooms | BA1 | BA2 | BA3 | BA4 | BA5 | BA6 |
|---------------|-----|-----|-----|-----|-----|-----|
| orientation   | Western | eastern | Southern | northern | Western | northern |
| The intensity of illumination at the patient's head Lux | 765   | 1615  | 1602  | 346  | 679  | 522  |
| Average Luminance Lux | 764   | 1625  | 1581  | 398  | 637  | 504  |
| The ratio of higher / lower light intensity | %100  | %99   | %99   | %87  | %94  | %97  |

Table 9: Daylight measurements of Al-Sadiq Teaching Hospital

| No. | Indicators                             | values |
|-----|----------------------------------------|--------|
| 1   | Daylight factor DF                     | 20%    |
| 2   | The illumination ratio between the patient / the surrounding | 100% |
| 3   | The ratio of illumination between the patient / the opposite wall, TV Wall | 100% |
| 4   | Luminance Level (Lux)                  | 0%     |
| 5   | The diversity of lighting DI           | 0%     |
| 6   | Illumination uniformity (IU)           | 100%   |

6.2. Najaf Teaching Hospitals

The hospital consists of three floors. The same operational procedure steps were performed for the previous hospital, and the following results were reached.

Table 10: Daylight measurements of Najaf Teaching Hospitals

| No. | Indicators                             | values |
|-----|----------------------------------------|--------|
| 1   | Daylight factor DF                     | 80%    |
| 2   | The illumination ratio between the patient / the surrounding | 100% |
The ratio of illumination between the patient / opposite wall, TV Wall

Luminance Level (Lux)

The diversity of lighting DI

Illumination uniformity (IU)

|   | Description                                                                 | Percentage |
|---|-----------------------------------------------------------------------------|------------|
| 3 | The ratio of illumination between the patient / opposite wall, TV Wall       | 60%        |
| 4 | Luminance Level (Lux)                                                       | 80%        |
| 5 | The diversity of lighting DI                                               | 100%       |
| 6 | Illumination uniformity (IU)                                               | 100%       |

7. Results

The results were obtained through field visits, and Daylight measurements in hospitals were taken. The results obtained in the two hospitals were compared to find out the best design solutions through a comparison between the two hospitals.

8. Analysing the results

In this section, the findings of the practical study will be analysed, as follows:

A. According to the Iraqi environment, the daylight factor is 1%. The hospitals were far from this required percentage, and the closest one is Najaf Hospital as the rate of daylight factor.

B. The illumination ratio between the patient / the surrounding: The lighting intensity ratio varied between the lowest light intensity and the average light intensity of the space, as dark areas appeared within the average lighting intensity of the space.

C. The ratio of illumination between the patient / the opposite wall, TV Wall as the maximum permissible ratio was 1-10, and Babel was more homogeneous between the intensity of illumination between lighting at patient's head and TV wall.

D. The level of illumination intensity. The intensity of lighting varied inpatient rooms and most of the lighting intensity was higher than the standard intensity required for patients' rooms (100 lux). Najaf Hospital was relatively close to the standard value of illumination intensity.

E. Variety of lighting: the rooms differed in terms of lighting diversity (the difference between the highest value and the minimum value does not exceed 1: 5). Most of the rooms had an acceptable diversity in terms of lighting.

F. Unification of lighting: the lighting near the patient was homogeneous, and there was no difference between the illumination of the patient and the lighting in the surrounding area, which reduces stress on the patient.

9. Conclusions

Through the implementation of the practical side, the following conclusions were reached:

Figure 14: Comparative between Al-Sadiq Teaching Hospital in Babil and Najaf Teaching Hospital in Alnajaf
1- Patient rooms overlooking the east and south façades help recover patients compared to rooms on the north and west façades.

2- The closer the lighting is above the patient's head, and the TV wall, the more comfortable the feeling of space is, helping the patients heal.

3- At the Illumination ratio level on the patient's room affected by the more homogeneous the Daylight distributed in the space, the more consistent the illumination ratio is.

4- Daylight factor 1%, which was determined in this research, can be adopted as a design indicator for Iraqi hospitals.

5- The illumination level required for patient rooms is 100 lux, and none of the hospitals achieved this ratio. To reach this intensity of light, the designer must work on all the indicators that have been taken to reach the required light intensity.

References
[1] Anjali J, 2006, Impact of Light on Outcomes in Healthcare Settings, Published by the Center for Health Design.
[2] Pennings E 2018 The influence of Daylight and artificial light on the circadian rhythm, length of stay and pain levels of hospital patients, Wageningen University. P: 4-17
[3] Joarder A R, and Price A D F 2013. Impact of daylight illumination on reducing patient length of stay in hospital after coronary artery bypass graft surgery. Lighting Research Technology.
[4] Huang, L., (2012) Safety and immunogenicity of a novel human Enterovirus 71 (EV71) vaccine
[5] Begemann S H A, & others, 1996 Daylight, artificial light and people in an office environment, an overview of visual and biological responses. International Journal of Industrial Ergonomics.
[6] Thorne H C, & others,2009. Daily and seasonal variation in the spectral composition of light exposure in humans. The Journal of Biological and Medical Rhythm Research.
[7] De Molenaar J G 2003 Lichtbelasting. Overzicht van de effecten op mens en dier. Wageningen, Alterra, Research Institut voor de Groene Ruimte. Alterra-rapport.
[8] Santhi, N & other, (2012). The spectral composition of evening light and individual differences in the suppression of melatonin and delay in humans' sleep. Journal of Pineal Research.
[9] Frisk, U., Olsson, J., Nylén, P., & Hahn, R.G. (2004). Low melatonin excretion during mechanical ventilation in the intensive care unit. Clinical Science.
[10] Sansone, R.A., & Sansone, L.A. (2013). Sunshine, serotonin, and skin: a partial explanation for seasonal patterns in psychopathology? Innovations in Clinical Neuroscience.
[11] Keith Robertson M. Arch, NSAA, Solterre, (1999) , Design daylight ing Guide for Buildings Ontario Association of Architects.
[12] Walch, J.M., Rabin, B.S., Day, R., Williams, J.N., Choi, K., & James, D. (2005). The effect of sunlight on postoperative analgesic medication use: A prospective study of patients undergoing spinal surgery. Psychosomatic Medicine.