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REVIEW ARTICLE

A Platinum-Graded Green Hospital Building in India during COVID-19 Pandemic: From Planning to Execution and Outcome

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Abstract

Background: A green hospital building has superior qualities over general hospital buildings in terms of energy conservation, use of natural resources, clean indoor air quality, green housekeeping, and other characteristics that improve patient outcomes. During the COVID-19 pandemic, healthcare organizations worldwide faced significant challenges and difficulties running hospitals. These challenges motivated the healthcare administration to find possible solutions for possible protocols for the functioning of the hospital. **Methods:** It was a prospective study conducted at a tertiary care hospital in north India from March 2020 to Feb 2022. After multiple changes in the fields of committee formation, human resource management, training, setting of the donning area and the doffing area, setting of the patient care areas and the infection control practices, equipment utilization, protocols for the support services, patient status updation to family members, and finally maintaining the patient data for the official purpose. **Results:** The hospital statistics showed a recovery rate of 81%, a mortality rate of 18%, and average length of stay of 8 days in COVID-19 patient care. **Conclusion:** The experiences, the challenges learned, and the solutions made to combat this pandemic will be the guide for future pandemics. The green hospital building proved its supremacy in patient outcomes and is recommended by hospital administrators as a future hospital building.

Keywords: COVID-19, Green Hospital Building, Challenges, Solutions, Outcome

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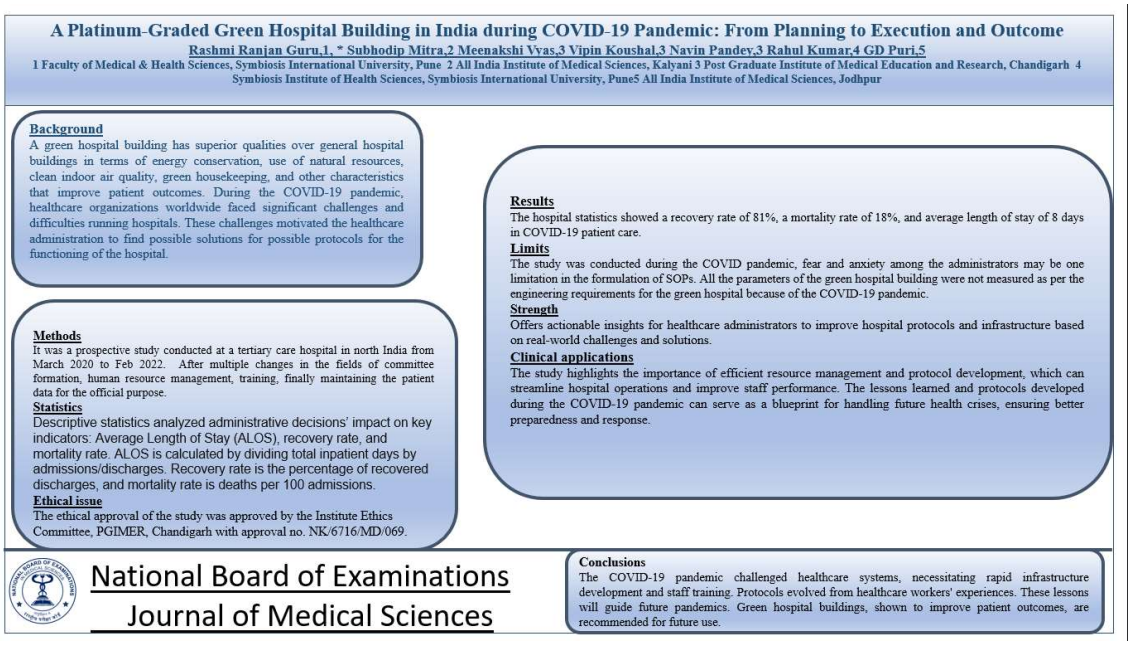
Graphical Abstract



Introduction

The WHO Director-General declared the COVID-19 outbreak as a public health emergency of international concern on 30th January 2020 [1]. Postgraduate Institute of Medical Education and Research (PGIMER) is a tertiary care hospital and a research institute in Chandigarh, India. It is the leading tertiary care hospital in the region of Chandigarh, Punjab, J&K, Himachal Pradesh, and Haryana. PGIMER has state-of-the-art facilities encompassing all specialties and super specialties. It was 21st January 2020, India, one official circular from the Medical Superintendent, PGIMER, Chandigarh was circulated throughout PGIMER on the matter of preparedness for the COVID-19 situation.

On March 14, 2020, the health secretary sent a message t4o start a dedicated COVID hospital within PGIMER as soon as possible and the building, Nehru Hospital Extension (NHE) was chosen for the dedicated COVID Hospital. The hospital was graded as a platinum-graded green hospital building by the Indian Green Building Council (IGBC). A green hospital building has superior characteristics to the general hospital buildings in terms of energy conservation, use of natural resources, clean indoor air quality, green housekeeping, and other characteristics that improve patient outcomes. Transforming the commissioned NHE into a fully functional setup within a fortnight presented an immense challenge for the hospital administrators. A COVID-19 Management Committee was formed, comprising experienced professionals from all departments of the hospital. Their continuous efforts transformed the partially functional hospital into a COVID isolation facility within a short period [2].

The competent authority conducted meetings to establish committees for COVID Management and a team of faculty and residents from different departments took on leadership roles as shown in Figure 1.

Figure 1. Shows COVID-19 Management Committee and the team

A training committee comprising faculties trained the healthcare workers and managed their accommodation, diet, and transportation. Respective departments created rosters and sent HCWs to the training committee. Training sessions were conducted in Lecture theaters adhering to social distancing guidelines as shown in Figure 2.

Figure 2. Shows the training of the HCWs during the COVID-19 pandemic

A CCTV control room with an announcing system directed the movements of the patient and staff. The overall control of all areas was managed by the control room run by the Dept. of Hospital Administration around the clock. The patients were monitored through the facility by camera and televisions in the control room as shown in Figure 3.

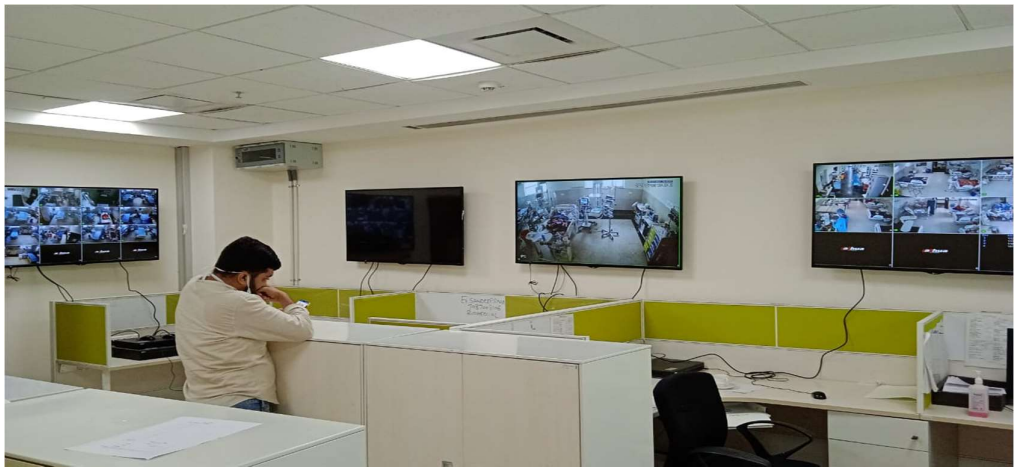


Figure 3. Patient Monitoring Control Room in COVID Hospital

Aim of the Study

The article aimed at challenges faced during this preparation and operation phase along with their innovative solutions are being highlighted hereon and its results.

Methodology

It was a prospective study conducted at a tertiary care hospital in north India from March 2020 to Feb 2022. The patients with COVID-19 infection admitted to the hospital were included in the study and the patients without the COVID infection were excluded from the study. A total of 6580 patient admissions were considered as the sample size. The administrative decisions, Standard Operating Procedures, training for the HCWs, and other policies were used as tools for the study. The descriptive statistics were used to analyze how these administrative decisions led to the changes in some crucial indicators such as Average Length of Stay (ALOS), recovery rate and mortality rate, ALOS which is the average number of days that a patient spends in the hospital and was calculated by dividing the total number of days in the hospital for all the patients during a certain period (patient days) by the number of admissions or discharges as shown below:

$$Average\ length\ of\ stay\ (in\ days) = \frac{Total\ inpatient\ days}{Total\ admissions\ or\ discharges}$$

The recovery rate is the percentage of patients discharged from the hospital as successfully recovered and is calculated by dividing the no. of patients discharged as "recovered" by the total no. of discharged patients. The result is multiplied by 100 to convert to a percentage as shown below:

$$Recovery\ rate\ (\%) = \frac{No.of\ patients\ discharged\ as\ "recovered"}{Total\ no.of\ discharged\ patients} \times 100$$

The mortality rate is the number of deaths that occur in a hospital in a given year, it can be seen as the number of deaths per 100 patients admitted in a hospital.

Results

The total number of patients admitted to the COVID hospital was 6580(N). Among them 4063 were male and

2517 were female. 5353 patients were discharged from hospital to home. 1227 number of the patients died during that period. The average number of stays was 8 days, the recovery rate was 81% and the mortality rate was 18.65%. The results are shown in Figure 4.

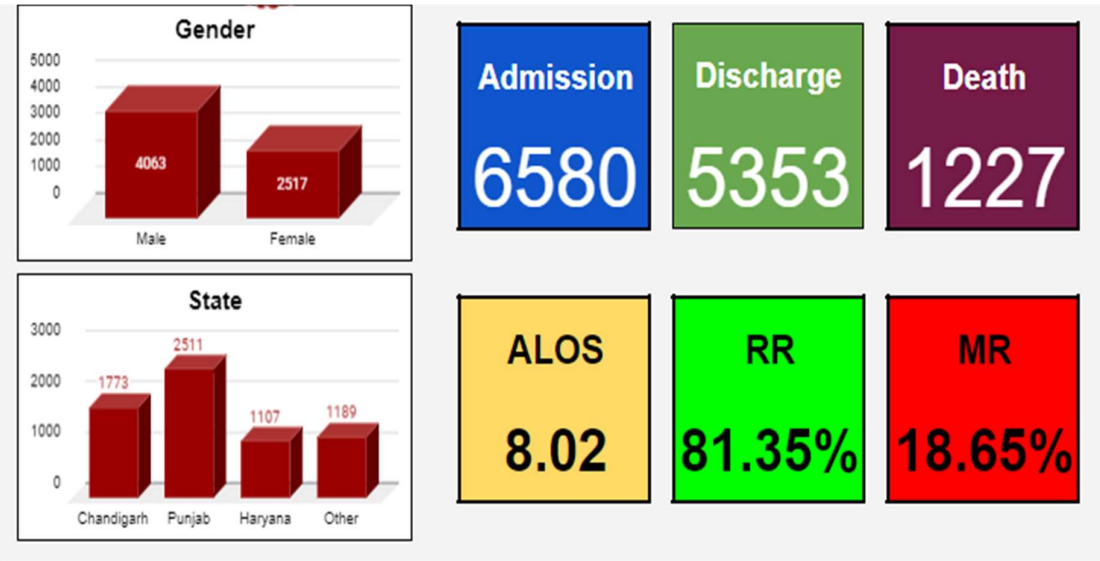


Figure 4. Shows the Hospital Statistics of the COVID-19 Pandemic Era

The Total number of patients admitted to the general hospital building was 2650. Out of the 2650 patients, 2309 number of patients recovered from COVID-19, and 341 deaths occurred. A comparison study is shown in Figure 5.

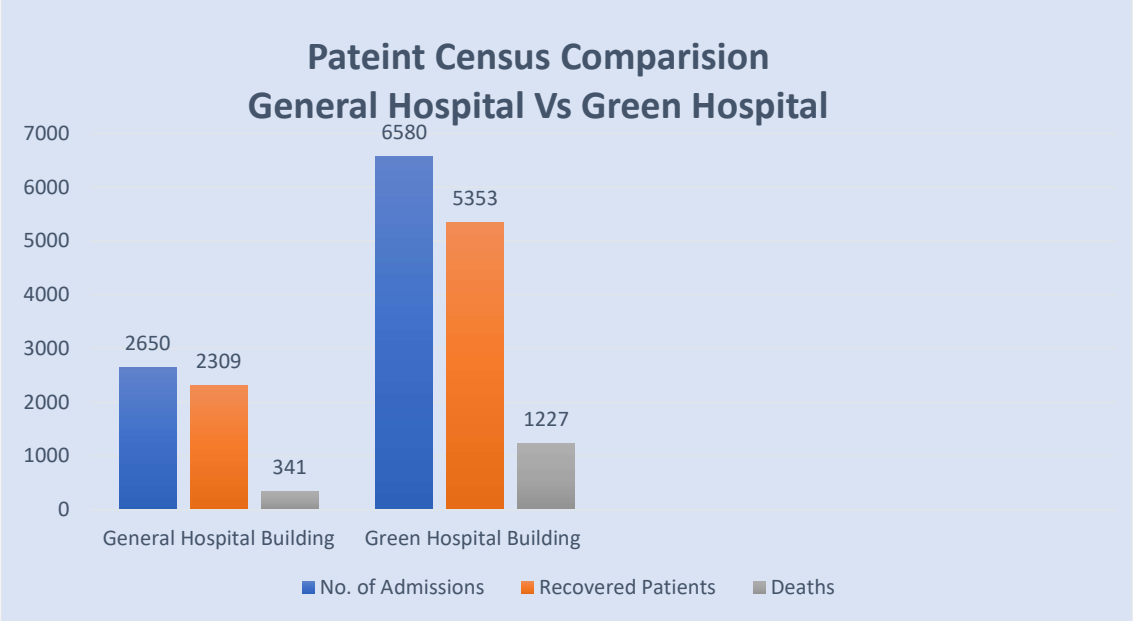


Figure 5. Shows the Hospital Statistics of the COVID-19 Pandemic Era

Discussion

The competent authority conducted meetings to establish committees, for the COVID Management and a team of faculty and residents from different departments took the leadership roles many authors mentioned in their articles [3].

The ICUs of the newly commissioned building were deficient in Heating Ventilation Air Conditioning (HVAC) with negative pressure, RO water supply, UPS backup & generator backup, domestic water supply, water supply to the dialysis facility, drainage of the wastewater of the dialysis machine, hospital information system, radiology workstation, landline telephone connections, remote viewing cameras for the patient care from the control room. The institute's engineering department and the Central Public Works Department (CPWD), Govt of India joined hands to expedite the process. Pre-operative, post-operative, and palliative care unit beds were transformed into 58 fully equipped ICU beds. Ward beds with ventilator connectivity were converted into 108 semi-equipped HDU beds. Additionally, 140 beds were created by utilizing private rooms with patient and attendant beds as step-down beds. This resulted in a total of 306 beds for COVID-19 patients, including a resuscitation area with three beds and a Cath lab mentioned by another author [4].

A training committee comprising faculties trained the healthcare workers and managed their accommodation, diet, and transportation [5]. Training sessions were conducted in Lecture theatres adhering to social distancing guidelines. HCWs received training on various guidelines and protocols, followed by orientation on their duties and responsibilities, and hands-on training on equipment like ventilators. Accommodation was arranged in private rooms within the hospital and hotel rooms provided by the institute at the start of the pandemic but later discontinued. Google forms were used for the booking process of rooms for the staff who were posted for COVID-19 duty every week.

A clean area was designated for administrative work, while contaminated red areas were created by installing glass doors in the hospital building [6]. Separate entry and exit gates were established for staff and patients. Initially, donning and doffing rooms were set up but later converted into donning and doffing corridors to accommodate 450 staff per shift. A doffing control room with real-time remote surveillance and an announcing system for stepwise doffing to minimize errors was established. Senior faculty utilized the facility of cameras installed over ICU beds and HDU cubicles for remote assessment. Patient counselling took place in the reception area, with OPD parking ensuring social distancing. Clinical control rooms enabled daily patient management discussions, while a nursing control room managed consumables and drugs around the clock. A CCTV control room with an announcing system directed patient and staff movements. The overall control of all areas was managed by the control room run by the resident doctors, Dept. of Hospital Administration around the clock.

The task of sorting lab samples was highly challenging. Initially, the lab samples were sent through a ramp. The physical effort exerted by attendants to climb the ramp caused delays in sample transport and missing of samples which few authors mentioned in their studies [7].

The area near the patient lift, providing access to outside and various labs

and the ABG lab, was chosen as the sample sorting station, which was equipped with CCTV cameras, sample-keeping trays, sorting containers, and a refrigerator to maintain cold chains, it ensured efficient handling of the sample. An LED screen in ABG Lab was used to monitor sample arrival at the laboratory. Vaccine carriers were used to maintain the cold chain during transportation.

With the increase in patients, the number of staff also increases, the new donning corridor is fully equipped with 47 donning stations used for 100 staff going for duty, as mentioned in other studies [8]. The donning area has two attendants deployed to help in donning. The Epicollect-5 surveillance mobile application was used for easy data entry and to speed up the process of donning.

The HVAC system was set to fresh air mode with closed return ducts and exhaust fans initially, but this caused problems in the AC's functionality [9]. To address this, air sampling was conducted multiple times, confirming the absence of the virus in the air at the roof level. Return ducts were opened. Oil heaters were placed near patient beds to maintain the desired room temperature. Precautionary measures were implemented to prevent fire incidents.

In the initial phase of setup, essential equipment such as ventilators, syringe pumps, monitors, ECG machines, ECHO, radiology workstations, portable X-ray machines, sonoclot machines, and portable ABG were needed for patient care. The challenge was to procure and arrange the necessary equipment for patient care. It was decided to temporarily relocate equipment from non-operational patient care areas for use in the COVID hospital until new equipment arrived. Ventilators were later received from the Prime Ministers Care Fund (PM Care), but their unique input system posed challenges for doctors. Regular training sessions were conducted to familiarize residents and nurses with ventilators and other equipment [10].

Initially, due to the building's commissioning stage, the dialysis facility was unavailable. As the first chronic kidney disease (CKD) patient was admitted to the ICU, a dialysis setup was arranged. With the increasing number of dialysis patients, a dedicated room with four fully equipped stations was established. However, during the hot summer, the heat caused the water temperature to rise, resulting in the malfunctioning of the dialysis machines. Reverse Osmosis (RO) water connection was given to the dialysis machines and two storage tanks were kept in the corridor with one pump to provide cool water to the dialysis machine, few authors mentioned in their studies [11].

A CCTV camera was installed at the staff entry gate and near the staff lift to speed up the process of registering for attendance purposes. Staff duties and responsibilities were described during the orientation program. A register was made for the nursing supervisors and sharing shift details on the WhatsApp group for supervision [12].

In root cause analysis for the maintenance of inventory of linen gowns, it was found that the staff put the linen gowns in the yellow color bins (used for disposable items) hence they were misused because they were sent for disposal. As a solution Linen hampers were placed in doffing areas and wards for storing gowns, and the nursing supervisor shared linen records via the WhatsApp group for verification [13].

COVID-positive patients were demotivated during their transfer to the

radiology centre due to the reluctancy shown by the staff. To streamline patient shifting to radiology a dedicated transportation team comprising a resident doctor, nursing officer, hospital attendant, sanitary attendant, and ambulance driver was formed. Coordination was facilitated through the WhatsApp group. A checklist of essential equipment was provided to ensure availability before shifting the patient. Additionally, a specialized radiology team was established to coordinate the patient transfers to radiology procedures [5].

Upon a patient's recovery and medically fit for discharge or obtaining two negative test results, the respective department issued a discharge slip. The hospital administration's control room initiated the discharge process. The COVID area resident then directed the patient to the ambulance bay, facilitating discharge with a discharge file, flowers, and post-COVID care guidelines. Coordinating these steps was a time-consuming challenge. A patient discharge group was made on WhatsApp, and all the staff involved were added for faster information concerning the discharge. This saved time and enabled a faster discharge process.

Sharing COVID patient details with various departments and entities, including the data center, Medical Record department, virology department, ICMR portal for data entry, RT-PCR reporting, laboratories, and clinicians, proved to be a time-consuming process. A dashboard was made by using a Google Excel sheet from where information regarding patient details, admissions, discharges, death and was shared with the departments and institute website. The COVID Hospital in India was a 300 bedded facility under Govt of India serving more than 6850 patients with a mortality rate of 18.65% and recovery rate of 81.35% with average length of stay was 8 days [14].

A hand hygiene chart of different areas was made for comparison between all the ICUs and wards. The chart was posted in all the groups, the clinical rounds, and the training sessions. An hourly announcement via the Public Announcement System was made as a reminder of hand hygiene, and unique steps none of the authors mentioned this but mentioned by the same author [15].

The brachytherapy OT was purposed as a functional Cath lab, with essential equipment such as a C-Arm, echo machine, monitor, defibrillator, OT lights, backup OT spotlight, and a resuscitation trolley. Staff members were assigned, and consumables were arranged, enabling the Cath lab to begin procedures [16].

Coordination delays occurred in sending blood product requests to the blood bank, resulting in prolonged sample receipt, cross-matching, and issue of blood products. Additionally, the absence of a blood return policy led to the wastage of numerous blood units. To reduce paperwork, an option for blood product requests was implemented in the Hospital Information System (HIS). A WhatsApp group was created for efficient coordination with the blood bank doctors. A blood product return policy was established, involving wiping the product with alcohol-based hand sanitizer and disinfecting it in an ultraviolet light box for 30 minutes after 48 hours of issue and then returned to the blood bank from the COVID ward. A dedicated register was maintained by the nursing supervisor in the COVID area to track the blood products returned [17].

Every week, nursing officers, resident doctors, and hospital administration received training in ICU

procedures and job responsibilities. Additionally, a mega critical care workshop was conducted providing training to a group of around 85 resident doctors and nursing officers at a time keeping social distancing measures [18].

A multidisciplinary team of doctors was formed, with round-the-clock receptionists to address family calls. Junior doctors utilized a dedicated phone to update family members on the status of stable patients while for critical patients, physical meetings were arranged at the hospital's spacious reception area to ensure social distancing.

The green hospital building has superior qualities to the general hospital buildings in terms of energy conservation, use of natural resources, clean indoor air quality, green housekeeping, and other characteristics that improved patient outcomes in terms of increased recovery rate and decreased mortality rate shown in figure 5.0 [19,20].

Limitation

The study was conducted during the COVID pandemic, fear and anxiety among the administrators may be one limitation in the formulation of SOPs. All the parameters of the green hospital building were not measured as per the engineering requirements for the green hospital because of the COVID-19 pandemic.

Recommendation

The formulation of the administrative rules and the Standard operative procedures are recommended to be made before starting any work in the hospital. The Green hospital buildings are recommended for their superior characteristics in terms of energy savings, infection prevention methods, and use of natural resources.

Conclusion

The COVID pandemic has presented an unprecedented challenge to healthcare systems. Healthcare organizations faced challenges in various aspects, including infrastructure development and staff training. Protocols were developed based on experiences faced by the healthcare workers. The experiences, the challenges learned, and the solutions made to combat this pandemic will be the guide for future pandemics. The green hospital building proved its supremacy in patient outcomes and is recommended by hospital administrators as a future hospital.

Statements and Declarations

Ethical Approval

The ethical approval of the study was approved by the Institute Ethics Committee, PGIMER, Chandigarh with approval no. NK/6716/MD/069.

Competing Interests and Funding

The authors declare that they do not have any financial or non-financial interests that are directly or indirectly related to this article.

Conflicts of interest

The authors declare that they do not have conflict of interest.

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