



Research Article

GREEN HOSPITAL INITIATIVES TOWARD SUSTAINABILITY: A STUDY AT A TERTIARY CARE SUPERSPECIALITY HOSPITAL IN NORTHERN INDIA

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ABSTRACT

Background: The concept of "Green Hospital" seeks to redefine how medical institutions are constructed to preserve human life, at the same time protecting the environment. **Aim:** To research the hospital's advancements toward becoming a green, climate-friendly hospital. **Material and Methods:** A retrospective observational study was conducted at Shri Mata Vaishno Devi Narayana Superspeciality Hospital (SMVDNH) from 24th July 2022 to 8th September 2022 to examine the hospital transition to becoming a green hospital.

The WHO Seven guidelines for a hospital that is climate friendly are the foundation of the study. **Results:** It was observed that hospital had implemented several initiatives focusing on improving its energy efficiency such as substituting LED light. Solar water heating system and rain water harvesting pits have been established for resource saving and efficient use. With a sewage treatment plant to handle liquid waste and BMW waste management and recycling in accordance with the rules, efforts have been made toward waste minimization and efficient management. **Conclusion:** This study highlights the hospital's commitment to provide a healthy environment for patient's wellbeing.

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INTRODUCTION

Healthcare facilities should provide a therapeutic & comfortable environment in which the overall design of the hospital building and its surroundings contribute to the process of healing, rather than simply being a place where patient receives treatment. This change of paradigm implies that both healthcare planning and design processes must be broad enough to include not only the issues surrounding the treatments, but also the promotion of health and prevention of disease by establishing a safe and therapeutic care environment. According to the World Health Organization, 'environments are considered therapeutic (with healing qualities) when there is direct evidence that a design intervention leads to improved patient's outcome. (1) According to Indian Green building council, a green hospital building can be defined as one which enhances wellbeing, aids the creative process, while utilizing natural resources in an efficient environment friendly manner. (2) The United States Environmental protection agency, a green hospital can be defined as "The practice of creating structures and using processes that are environmentally responsible and resources efficient throughout a building's life cycle from site to design, construction, operations, maintenance, renovation and deconstruction.(3) According to Healthcare Without Harm "A Green and healthy hospital is the one that promotes public

health by continuously reducing its environmental impact and ultimately eliminating its contribution to the burden of diseases.(4) Green hospitals are sustainable hospitals. The concept of 'green buildings' can be traced to the United Nations dedicated efforts, over the years, to bring to the fore the idea of 'sustainability' in all aspects of human development. The first such effort made in this direction was the United Nations Conference on Human Environment, held in 1972 at Stockholm. Within the declaration of this conference, it was proclaimed that, "The protection and improvement of the human environment is a major issue which affects the well-being of people and economic development throughout the world, it is the urgent desire of the people of the whole world and the duty of all governments" (5) The green hospital movement began years ago following the U.S. Green Building Council (USGBC)'s release of their Leadership in Energy and Environmental Design. This study was planned in a 250-bed tertiary care teaching SMVDN superspeciality hospital in the union territory of Jammu and Kashmir to assess the initiatives taken by the SMVDNH toward becoming climate friendly hospital.

MATERIAL & METHODS

The study was conducted in SMVDN hospital for One month 46 days (24th July to 8th September 2022) to analyze hospital

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journey toward becoming a green hospital. The study is based on WHO Seven directives of a climate friendly hospital. It is a retrospective observational study. Data was gathered from primary and secondary sources of information. The primary data was collected through checklist. The secondary data was collected from Facility department journals, articles, website, various publications relating to healthcare system, publications of executing agencies viz WHO, publication of MoHFW, were also reviewed. The tool used for this study was check list. Check list was the major instrument for collecting data for this study. The checklist was carefully structured and simply designed in order to ensure easy answering. The parameters in checklist were personally collected for analysis and analyzed to aid reasonable findings and conclusions for the study. The targeted population of this study consisted of the SMVDN hospital. MS excel was used for statistical analysis. Percentage was used to analyzed the following work was completed in order to facilitate data analysis. Computerized tabulation was used to create statistical tables. Variables were represented in columns and rows. Pie chart were created to show the result.

Observation and Findings

Building Design

The hospital spans 125 acres, encompassing both medical facilities and residential areas. It was constructed in 2016, featuring an environmentally-friendly architectural design. The hospital boasts wide corridors, ensuring ample space for movement. The wards are equipped with abundant natural light and ventilation. Additionally, the cafeteria area utilizes natural exhaust fans, while its rooftop is designed to maximize sunlight and aid in electricity conservation. Indoor plants are also incorporated throughout the hospital. The hospital boasts a herbal garden covering approximately 60-70% of its area, filled with trees that create a calming atmosphere for patients. In an effort to prioritize the well-being of patients, no cytotoxic chemicals are used within the hospital premises. Additionally, the hospital adopts environmentally friendly practices such as utilizing STAR rated equipment and procuring Ozone-depleting Substances (ODS) free and mercury-free instruments. More than 70% of the campus is dedicated to green spaces and natural surroundings, providing comfort to both outpatients and in-patients. The beautiful gardens and landscapes not only enhance the aesthetic appeal but also contribute to the overall wellness of the patients. It has been observed that individuals exposed to plants tend to experience a higher level of positive emotions rather than negative ones. (Figure-1 and Figure-2)

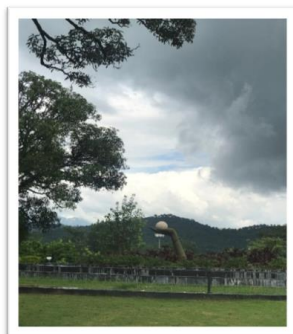


Figure 1 Herbal Garden

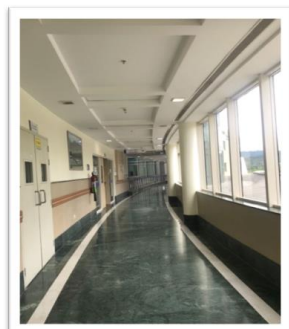


Figure 2 Well Spacious corridors

Lighting

SMVDN hospital has been strategically designed to effectively utilize daylight and minimize the need for artificial lighting in all areas dedicated to patients. Day-lighting refers to the intentional use of natural light, whether direct or diffused, to reduce the dependence on electric lighting in spaces such as corridors, the main lobby, reception, and other sections of the hospital that cater to patients. The hospital incorporates a glazed facade to provide views and natural daylight. Research has shown that daylighting has beneficial effects on patients in healthcare settings. As of 2021, all halogen and CFL lights have been replaced with LED lighting. The hospital area is equipped with high-quality 36/watt LED lights. Additionally, most of the street lights are now LED-based. Dr. Akshita Abrol conducted a Kaizen study to enhance productivity and improve quality within the hospital (Figure-3) & (Figure-4)

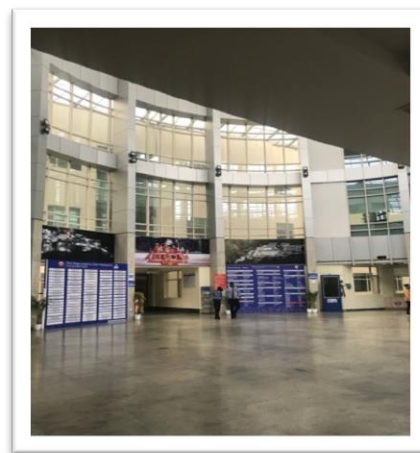


Figure 3 Natural light in the atrium



Figure 4 Day lightening in the ward

Alternative Energy Generation

Hospitals are taking several steps to encourage the use of sustainable energy sources. This includes installing solar water heating systems for various purposes such as laundry, toilets, emergency, and operating rooms. The system consists of a collector that collects solar energy and an insulated storage tank that stores hot water. Additionally, hospitals have replaced the expensive and polluting diesel fuel used in their laundry boilers with compressed natural gas (CNG).

Biomedical wastes

Hospital has multispecialty wards, seven OT, twenty OPD, emergency and laboratory services. A total of 200Kg of BMW per month is generated which include 30% incinerable waste,

58% autoclavable waste, 10% glass waste, and 2% sharp waste. All health care workers adopt standard precaution and safety measures while handling and disposing the health care waste. It is transported in separate color-coded trolleys as per the BMW 2016 rules. The waste storage site of this hospital is approximately 500 meters away from patient care areas. Hospital is using wheeled non- motorized trolleys, which do not require any fuel. There is no incinerator in the hospital. All infected plastic waste is autoclaved, shredded and handed over to an authorized facility. Glass waste is also recycled. Only sharp waste and incinerable waste is handed over to the Jammu Pollution Control Department authorized Common Biomedical Waste Treatment Facility (CBMWTF) for their respective treatment while the uninfected general waste is handed over to the municipal corporation. The health care workers are trained regularly on issues related to BMW management and encouraged for adopting safe practices during segregation, transportation, treatment and disposal of health care waste. Biomedical waste audits have been performed to improve waste segregation and reduction. Valid license from J&K State pollution Control Board (J&K PCB) for handling of biomedical wastes. All infected plastic waste is autoclaved, shredded and handed over to J&K PCB authorized facility. Utilization of recycled water of STP and ETP water for gardening purpose. Regulated waste disposal only through the J&K PCB approved vendors. During the audit of the biomedical waste in various departments data was analyzed through simple %. There was 96.36% of compliance and 3.64% of Noncompliance in segregation of waste. (Figure-5)

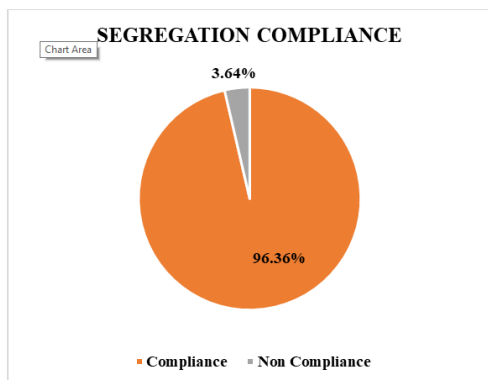


Figure 5 Segregation Compliance

Food

Fresh vegetarian meals are provided in the hospital, which also utilizes an organic waste converter. An organic waste converter is a device designed to treat and recycle both solid and liquid waste materials. This process involves converting solid waste into compost, a valuable byproduct that

contributes to environmental preservation. The machine operates through a mechanism that relies on the presence of air, effectively overcoming potential obstacles that might impede the process. It takes biodegradable waste as input and generates compost as the output. The use of Organic Waste Converter to automate and ease the process of composting is a step in the right direction. All biodegradable waste – leftover food, vegetable and fruit peel are converted into valuable compost that can be used for the organic farming. (Figure-6)



Figure-6

Water conservation planning

A water-efficient design strategy must balance the water quality and quantity requirements within a building and accommodate the capacity of the basin as a water source. To reduce water consumption and wastewater discharge, systematic research to identify potential water sources, how water is used in buildings, and how water flows around construction sites is critical. The goal is to minimize potable water consumption while maintaining water quality and availability, as well as maintaining external wastewater treatment and stormwater drainage from the site. The hospital has rainwater collection pits to help replenish groundwater. Groundwater is used in hospital cleaning systems and fire hydrants. Rainwater collection pits are designed to collect and store rain rather than letting it run off. For drinking, reverse osmosis (RO)-based water purification systems have been installed in all areas of the hospital and are available to staff and the public, eliminating the need for bottled water. The hospital has its own STP and ETP facilities. The water is treated and used for horticulture. Daily monitoring of water purifier via defined checklist was done. Water conservation initiatives- low flow aerators, dual flush. Periodic internal/external water audits. Reuse of RO reject water for other suitable purposes. (Figure-7) & (Figure-8)



Figure 7 Rain Water Harvesting Pits

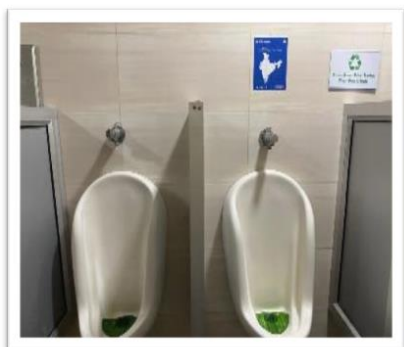


Figure 8 Water less urinal

Housekeeping practices

As part of existing policies, SMVDNSH have written procedures for selection and usage of cleaning products, mops, wipers used for the housekeeping purposes. Usage of glutaraldehyde-based disinfectants is restricted for general housekeeping activities. Use of VOC based air fresheners are prohibited, only water-based fresheners are used. Insist on selection environment friendly cleaning materials without compromising the patient safety. Adequate signages and poster at prominent location to sensitize employee and visitors on importance of hygiene and safety. Frequent training to housekeeping staff on safe handling and disposal of hospital wastes. Mandatory PPE usage must for housekeeping employee. Provide separate trained HAZMAT team for handling hazardous material and chemical spills. Selection of cleaning materials that meet environmental standards without compromising the patient safety. Facility is doing air quality and noise level monitoring testing in hospitals and also facility is doing regular waste testing of STP and ETP. Facility is doing regular pollution monitoring / Air testing of stack emission for DG sets and boilers. Facility is doing air culture testing in indoor patient's area including ICUs. Facility is doing regular OT monitoring and medical air quality testing. Monthly facility audit/ round to ensure safety & Quality in place.

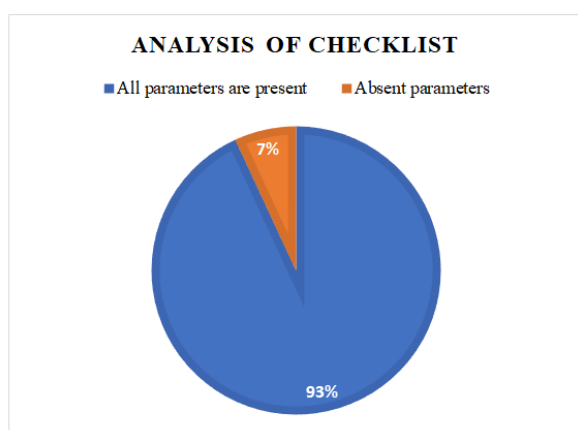


Figure Analysis of check list by simple %

- The absent parameters are
1. Do you recycle waste including plastic.
 2. Do your actively detects leak.

DISCUSSION

Developing countries like ours will be most significantly affected by climate change, leading to increased expenses and resulting in issues such as hunger, water shortages, and

resource scarcity. Hospitals can play a vital role in mitigating these effects by conducting comprehensive audits, providing training and education to staff, and implementing energy reduction measures. In India, the National Green Tribunal (NGT) has mandated hospitals to decrease their energy consumption by conducting third-party audits or relevant assessment studies. SMVDN Hospital has been working towards building a more climate friendly hospital since 2016. Hospital has introduced more energy efficient means like LED, purchasing energy efficient products. The result is the hospital's total energy consumption has remained steady over the years, despite the increase in patient load. WHO recommends incorporating green building principles in design and construction. The National building code of India has stressed upon the importance of natural light and ventilation, green building design, solid waste management, availability of local public transport system and installation of energy efficient systems in healthcare establishments to reduce Health sector's carbon foot prints. WHO recommends incorporating green building principles in design and construction [1]. The National building code of India has stressed upon the importance of natural light and ventilation, green building design, solid waste management, availability of local public transport system and installation of energy efficient systems in healthcare establishments to reduce Health sector's carbon footprint [6]. This has been emphasized in another review by Dhillon *et al.*, [7]. Sambhavna Trust Clinic, Bhopal is an example of green building design which includes gardens, rainwater harvesting system, SWHS, use of recycled water for irrigation, horticulture, cross-ventilation, and ample natural light [8].

Recommendations

It is recommended that the Hospital Administration should conduct hospital-wide audits and provide training & education to staff in-order to achieve a reduction in energy usage within the hospital.

CONCLUSION

The hospital has taken several measures to be environmentally friendly. Energy consumption has remained stable in recent years, despite the expansion of medical services and an increase in the number of patients. This shows strong commitment Hospital administration to conserving natural resources and protecting the environment. Health professionals should strive to be environmentally responsible by supporting the construction of carbon-neutral or carbon-negative health facilities.

Consent for Study

Informed consent was taken from all participants.

Conflict of Interest

The authors have no conflict of interest to declare.

Author Contributions

Dr. Akshita Abrol. wrote the manuscript in consultation with Dr. Mukul Gupta. Dr. Khalid Mehmood and Dr. (Brig) RS Saini. supervised the study, review literature review, study design and editing. All authors were involved in all steps for preparation this article, including final proofreading and gave final approval of the version to be published

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