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ENVIRONMENTAL IMPACTS OF COVID-19 HOSPITALS AND ARCHITECTURAL REMEDIES

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ABSTRACT

Pandemics, with their potential for widespread devastation and global impact, have historically been a critical concern for public health and society. the historical impact of pandemics on the environment underscores the interconnectedness of human lives and health, societal systems, and the environment, highlighting the need for holistic approaches to public health and environmental management. The COVID-19 pandemic has brought about significant changes in healthcare facilities worldwide, particularly in hospitals designated for COVID-19 patients to counter and serve the impact on humans which universally led to the rapid establishment of specialized hospitals to manage the surge in patients. However, such hospitals not only posed significant challenges to healthcare systems worldwide but also highlighted the need for sustainable practices in designing and operating healthcare facilities along with their significant environmental impacts. In response to these challenges, architects, designers, and healthcare professionals have explored innovative architectural and other remedies to mitigate the environmental impacts of COVID-19 hospitals. This paper explores these potential environmental impacts and proposes architectural planning strategies that include sustainable practices and green design principles through which, by implementing, COVID-19 hospitals or similar hospitals can minimize their environmental footprint and contribute not only to a more sustainable healthcare system but also create healthier and more sustainable environments for patients, healthcare workers, and the community at large.

KEYWORDS: *Hospital Environmental Impact, Hospital Environment Relation, COVID-19 Hospital Impact on Environment, COVID-19 Hospital Impact, Environmental Impact of Pandemics, Pandemic Hospital Impact on Environment*

INTRODUCTION

The COVID-19 pandemic has brought unprecedented challenges to healthcare systems worldwide, which has led to the rapid construction and adaptation of healthcare facilities to meet the surge in patient demand (WHO, 2020; Ezekiel J. Emanuel, 2020). It has passed its pandemic stage but now it has been predicted to become an endemic disease (Antia, 2021) which makes it important to study every aspect of science to not only counter its impact but also to learn from it but also to apply its learnings in future similar situations to collectively reduce its impact on the world. While hospitals played a crucial role in managing the pandemic and saving lives, their operations had significant environmental impacts (Ana L. Patrício Silva, 2021). It is important to extract and highlight these environmental impacts of COVID-19 so that they can be utilized and implemented in similar future situations. Hospitals can implement such strategies to not only reduce their environmental impact but also improve the health and resilience of patients, healthcare workers, and the community in such situations. After carefully reviewing the literature, the environmental impact of hospitals requires a comprehensive approach for the assessment that considers various aspects of their operations and activities. Several key parameters can be used to evaluate and measure this impact:

1. **Waste Generation**: Hospital waste generation is a significant environmental concern due to its complex and potentially hazardous nature. Hospitals produce a variety of waste types, including infectious waste, hazardous chemicals, and pharmaceuticals, which require specialized handling and disposal methods to prevent environmental contamination and public health risks. Managing hospital waste effectively is essential to minimize its environmental impact and ensure the safety of healthcare workers, patients, and the community (Elliott Steen Windfeld, 2015).
2. **Energy Consumption**: Hospital energy consumption is a critical aspect of healthcare facility operations, significantly impacting both operational costs and environmental sustainability. Hospitals are energy-intensive buildings due to the continuous operation of medical equipment, heating, ventilation, and air conditioning (HVAC) systems, and lighting. Energy consumption efficiency is essential for hospitals to reduce their carbon footprint, lower energy costs, and ensure reliable healthcare services (Spicer, 2019; Christiansen, 2015).
3. **Water Consumption**: Hospital water consumption is a key component of healthcare facility management, impacting both operational costs and environmental

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sustainability. Hospitals require water for various purposes, including patient care, sanitation, and facility operations. Water consumption is crucial for hospitals to reduce costs, minimize their environmental impact, and ensure sustainable water use practices (Balwani, 2017).

4. **Air Emissions**: Hospital air emissions refer to the release of pollutants into the atmosphere from various hospital activities and operations. These emissions can result from the combustion of fuels in boilers and generators, as well as from the use of chemicals and medical equipment. Air emission control is essential for hospitals to minimize their impact on local air quality and public health (Amin, 2021; Marco Gola, 2019).
5. **Transportation Impact**: Hospital transportation impact refers to the environmental effects of the movement of people and goods to and from healthcare facilities. This includes patient transport, staff commutes, and delivery of supplies. Efficient and sustainable transportation practices are crucial for hospitals to manage transportation impact, and reduce traffic congestion, air pollution, and greenhouse gas emissions (Solomon, 2020).
6. **Indoor Environmental Quality**: Hospital indoor environmental quality (IEQ) refers to the conditions inside healthcare facilities that affect the health, comfort, and well-being of patients, staff, and visitors. IEQ encompasses factors such as indoor air quality, thermal comfort, lighting, and noise levels. Maintaining high IEQ standards is essential for hospitals to provide a safe and healthy environment for all occupants (Marco Gola, 2019).
7. **Greenhouse Gas Emissions**: Hospital greenhouse gas (GHG) emissions refer to the release of gases such as carbon dioxide, methane, and nitrous oxide from hospital activities. These emissions contribute to climate change and global warming. Reducing greenhouse gas emissions is crucial for hospitals to minimize their environmental impact and promote sustainability in healthcare (Amin, 2021; Bozoudis, 2022).
8. **Chemical Management**: Hospital chemical management involves the proper handling, use, storage, and disposal of chemicals used in healthcare facilities. This includes cleaning agents, disinfectants, pharmaceuticals, and other hazardous substances. Effective chemical management is essential for hospitals to prevent environmental contamination, protect the health and safety of staff and patients, and comply with regulations (Charlier, 1993).
9. **Biodiversity Impact**: Hospital biodiversity impact refers to the effect of healthcare facilities on the surrounding environment's biodiversity. This impact can result from activities such as land use changes, habitat destruction, and pollution. Managing biodiversity impact is important for hospitals to minimize their ecological footprint and promote environmental conservation and sustainability (Manfred Lenzen, 2020).
10. **Sustainable Procurement**: Hospital sustainable procurement involves the purchasing of goods and services in a way that minimizes negative environmental, social, and economic impacts. This includes sourcing products that are environmentally friendly, ethically produced, and have a low carbon footprint. Sustainable procurement is essential for hospitals to promote sustainability throughout their supply chain and support the transition to a more sustainable healthcare sector (Wilburn, 2021).

METHOD

This research is based on the review of the literature which adopted a multi-phased random review approach to extract and review existing literature. The first phase of the research consisted of extracting literature related to the environmental impact of hospitals to extract the parameters that created the base to assess the environmental impact of hospitals at large. The second phase of the research consisted of extracting the literature on the environmental impacts of COVID-19 hospitals and architectural remedies which included research articles, reports, and case studies from academic and industry sources. Published Data on the environmental impacts of COVID-19 hospitals was collected from relevant sources from digital libraries searched from Google Scholar using different keywords since 2020 from which, data in English was considered. Conclusions were formulated based on relevant findings from the literature review along with the inputs from relevant professionals for healthcare facilities to implement these strategies to mitigate environmental impacts and promote sustainability.

RELEVANT FINDINGS

After conducting the literature review analysis, extracted relevant findings were divided into two main categories. Firstly, the environmental impacts, which discusses the enhanced environmental impact from such dedicated COVID-19 hospitals only as the overall impacts by other hospitals have been discussed earlier. Secondly, the architectural and other remedies for such hospitals have been discussed which will help in reducing their enhanced environmental impact.

ENVIRONMENTAL IMPACTS

1 Increased Energy Consumption: COVID-19 hospitals require intensive ventilation, heating, and cooling systems to maintain air quality and temperature control. This leads to higher energy consumption and increased greenhouse gas emissions (Wandong Zheng, 2021).

2 Waste Generation: The COVID-19 pandemic has had a significant impact on the healthcare sector, leading to an increase in the demand for hospital facilities and the generation of substantial amounts of medical waste (Water, 2020). Several studies have highlighted the environmental implications of this surge in healthcare activities. A study by Sarkodie and Owusu (2020) examined the potential increase in medical waste generation during the COVID-19 pandemic. They estimated that the global generation of medical waste could increase by approximately 600 tons per day, posing significant challenges for waste management systems (Sarkodie, 2021). Another study by Sangkham (2020) focused on the environmental impact of personal protective equipment (PPE) disposal in Thailand, highlighting the need for proper waste management strategies to mitigate the negative effects on the environment (Sangkham, 2020).

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3 Water Usage: As already witnessed, hospitals require large amounts of water for sanitation, cleaning, and medical procedures. The dedicated The increased demand for water in COVID-19 hospitals can strain local water resources, especially in areas already facing water scarcity (Othman Ahmed, 2023).
4 Chemical Usage: In response to the COVID-19 pandemic, hospitals and healthcare facilities have significantly increased their usage of various chemicals for infection control and prevention. Commonly used chemicals include disinfectants such as bleach, hydrogen peroxide, and quaternary ammonium compounds, which are effective against the SARS-CoV-2 virus. These chemicals are used to clean and disinfect surfaces, medical equipment, and high-touch areas to reduce the risk of transmission (Dewey, 2021).

ARCHITECTURAL AND OTHER REMEDIES

In terms of architectural remedies, several researchers have proposed strategies to address the environmental impact of hospitals during pandemics like COVID-19. Research advocated for the adoption of green building principles in the design and construction of healthcare facilities. They suggested incorporating features such as energy-efficient systems, water conservation measures, and sustainable materials to reduce the environmental footprint of hospitals (Capolongo, 2020). Tsai et al. (2021) explored the concept of modular and flexible hospital designs, which can be rapidly deployed and adapted to respond to surges in demand during pandemics. These modular designs allow for efficient use of resources and can be easily dismantled or repurposed after the crisis, minimizing waste and environmental impact. Beyond architectural remedies, researchers have also proposed other strategies to mitigate the environmental impact of COVID-19 hospitals. Jiang et al. (2021) emphasized the importance of effective waste management practices, including segregation, treatment, and proper disposal of medical waste. They also recommended the adoption of circular economy principles, such as waste reduction, reuse, and recycling, to minimize the environmental burden. Another architectural solution proposed by Capolongo et al. (2020) involves the implementation of infection control strategies in hospital design. Similar to the studies witnessing the strategies to control infection in hospital departments such as in the burn unit (Aziz, 2023) ,ophthalmology (Arafat Aziz T. N., 2023), dentistry (Arafat Aziz S. C., 2023), etc, dedicated COVID 19 hospital includes the incorporation of advanced ventilation systems, segregated areas for infectious patients, and materials that facilitate effective cleaning and disinfection. Such measures can help reduce the spread of infectious diseases and minimize the environmental impact associated with decontamination and waste disposal. Other remedies in context to COVID 19 are summerized:

1. Energy-Efficient Design: Designing COVID-19 hospitals with energy-efficient features such as natural ventilation, high-performance insulation, and energy-efficient lighting can reduce energy consumption and lower greenhouse gas emissions.
2. Waste Management Practices: Implementing effective waste management practices, including segregation, recycling, and proper disposal of medical waste, can minimize the environmental impact of COVID-19 hospitals.
3. Water Conservation Measures: Installing water-efficient fixtures, implementing rainwater harvesting systems, and promoting water recycling can help reduce the water footprint of COVID-19 hospitals.
4. Green Building Certifications: Seeking green building certifications, such as LEED (Leadership in Energy and Environmental Design), can ensure that COVID-19 hospitals adhere to sustainable building practices and minimize their environmental footprint.
5. Use of Eco-Friendly Materials: Choosing eco-friendly building materials and furnishings can reduce the environmental impact of COVID-19 hospitals and promote a healthier indoor environment for patients and healthcare workers.
6. Alternative Energy Sources: Integrating renewable energy sources, such as solar panels or geothermal systems, can help COVID-19 hospitals reduce their reliance on fossil fuels and decrease their carbon footprint.

CONCLUSION

The environmental impacts of COVID-19 hospitals are significant and multifaceted, requiring a holistic approach to mitigation. One of the primary environmental impacts of COVID-19 hospitals is the increased energy and resource consumption associated with their construction. The rapid construction of temporary facilities often relies on resource-intensive materials and processes, leading to higher carbon footprints. The increased demand for energy, water, and medical supplies in these facilities further strains already limited resources. Furthermore, the operational strategies employed in COVID-19 hospitals, such as enhanced ventilation and disinfection protocols, can have long-term environmental consequences. Increased both artificial ventilation and natural ventilation rates to reduce airborne transmission of the virus can lead to higher energy consumption. Architectural solutions, such as green building principles, modular designs, and infection control strategies, have been proposed to address these challenges. Additionally, effective waste management practices and the adoption of circular economy principles could further mitigate the environmental impact of healthcare activities during pandemics. The integration of green space systems can improve indoor air quality and reduce the reliance on mechanical ventilation at the same time, the use of chemical disinfectants can result in the release of harmful pollutants into the environment. To address these environmental impacts, architects and healthcare professionals are exploring various remedial strategies. These include the use of sustainable building materials and construction techniques to reduce the carbon footprint of hospitals, as well as the implementation of energy-efficient HVAC systems and renewable energy sources to minimize energy consumption.

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